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APPLICATION OF THE ELECTRIC LIGHT IN THEATERS.

THE danger of fire accompanying the use of gas for lighting theaters has given an extreme importance to the application of the electric light in these structures. Without taking up space to pass in review the different phases that such an application of the latter illuminating agent has already passed through in the various large cities of Europe and America, we shall proceed to give a description of the arrangement adopted for lighting the theater connected with the recent International Exhibition of Electricity at Munich. This theater consisted of a large hall that had been constructed in the nave for a special study of the question under consideration. All the necessary fittings, such as ornaments, scenery, side-scenes, etc., were furnished by the Théâtre Royal. The hall was capable of holding six hundred spectators, outside of the space reserved for the musicians. Its lighting was partly effected by means of six Schuckert lamps placed over a transparent glass disk in the ceiling. The intensity of the light projected was capable of being modified, according to requirements, by excluding several lamps from the circuit and substituting equivalent resistances for them.

In addition to this filtered light, the hall also received further light emanating from festoons of Edison lamps arranged along the walls, as had been done in the large association hall at the Exhibition of 1881, the two lights combined producing a very agreeable effect.

The stage was lighted solely, but completely, by Edison lamps, which were also used for the foot, strip, and border lights.

The lamps were arranged in such a way that they could furnish their own natural light, or project red or blue rays so as to produce certain special effects. This latter result was obtained by causing the light from each lamp to pass through a screen of colored gelatine that was readily brought in front of each lamp at the proper moment.

In the foot-lights, each lamp was surrounded at its base by a horizontal pulley whose circumference might be considered as divided into three parts. One of these parts remained free, another carried vertically a screen of red gelatine having a cylindrical curvature, and the third was provided with a like screen of blue gelatine. As shown in Fig. 1, a cord passed alternately in front of and behind all the lamps in succession, in such a way that when it was pulled it communicated to each two neighboring lamps an opposite motion; but the screens were so placed that one and the same pull on the cord while the lamps were uncovered brought in front of them all the red or all the blue screens.

In the border lights (Fig. 2) the arrangement of the screens was just the opposite, as the lamps were inverted; and, besides this, the cord acted in a different manner. The motion of one of the screens brought about in succession that of all the others; and from each screen there started two cords which permitted of a blue or a red screen being brought in front of the lamp, according as the pulling was done from one side or the other.

In the strip lamps (Fig. 3), the gelatine screens, instead of being parallel with each other in a vertical direction, were superposed and slid along two vertical rods, a cord passing over a pulley carrying them all along at one and the same time.

In all these screens the gelatine was supported by a wire meshwork.

The lighting of the stage likewise included apparatus (Fig. 4) designed to throw a brighter light upon certain points—upon the background, for example. These apparatus consisted of three rows of Edison lamps mounted in an inclined case forming a reflector.

The system was rendered complete by arc projectors.

For regulating the incandescent lamps recourse was had to a well arranged play of resistances. The resistance wires, which were placed in a large open box, were capable of being introduced progressively into each circuit by the aid of a series of handles arranged upon a table above, while inscriptions upon the latter indicated the circuit to which each handle belonged. Besides this, the extremities of all the handles rested against one and the same bar, and by means of this all of them could be maneuvered together, either all at once by hand, or progressively by means of a screw fixed at the edge of the table.

Fig 6 shows how the different apparatus that we have just passed in review were placed upon the stage.

While the Munich Exhibition lasted, ballets were given in this theater every evening, and on the 26th of September a congress of its directors gave an opinion which was favorable to the lighting of places of amusement of this kind by electricity, especially because of the absence therefrom of all dangers from fire.

"In fact," says the official report of the Munich Exhibition upon this subject, "incandescent lighting, aside from the security that it presents as regards danger from fire, possesses a whole series of advantages that are at once apparent. Thus, before all else, the heat produced by incandescent lamps, compared with that emitted by gas burners, is exceedingly small. On another hand, they do not consume oxygen and do not smoke, these being advantages that will be appreciated by artists particularly who have to produce effects by means of their lungs and throat.

One very important fact is that the lighting and regulating of incandescent lamps, either all together or separately, can be done from any one point by one man without presenting the danger that results from the use of gas for the border lights. Besides this, the incandescent light possesses certain properties that are of infinite value from a decorative point of view; for it can be arranged anywhere without danger, and it gives a warmer and more sunlike color, this being an important matter for the painting of the decorations. It is particularly steady, so that the tone of the decorations remains always the same. It exerts no influence, as arc lamps do, upon the color of the costumes and decorations that have been prepared with a view of being exhibited under gas light. Combined with arc projectors, lighting by incandescence permits of obtaining an intensity that has been hitherto unknown, and also of attaining complete darkness, this being something that is never effected with gas. It will therefore be possible, by using it, to obtain through imperceptible gradations, in a sunrise scene, all the shades of night, of the aurora, and of full sunlight, or, in a storm scene, to produce sudden effects of light, such as those of flashes of lightning."

In short, the theater arranged in the Munich Crystal Palace has shown once again the possibility of employing incandescent lamps in such places, on combining them with arc lamps for the lighting of the auditorium and for certain stage effects.

The question has reached such a point that we can now give an opinion as to its future. In our opinion, the lighting of theaters by incandescent lamps, combined with arc ones, in the measure that we have indicated, is called upon to assume a greater and greater development.

The fact that most theaters are now provided with a very complete and well understood system of gas lighting will certainly retard such progress, although it will be favored, on another hand, by two other circumstances, and that is, the facility with which all danger of fire can now be re-

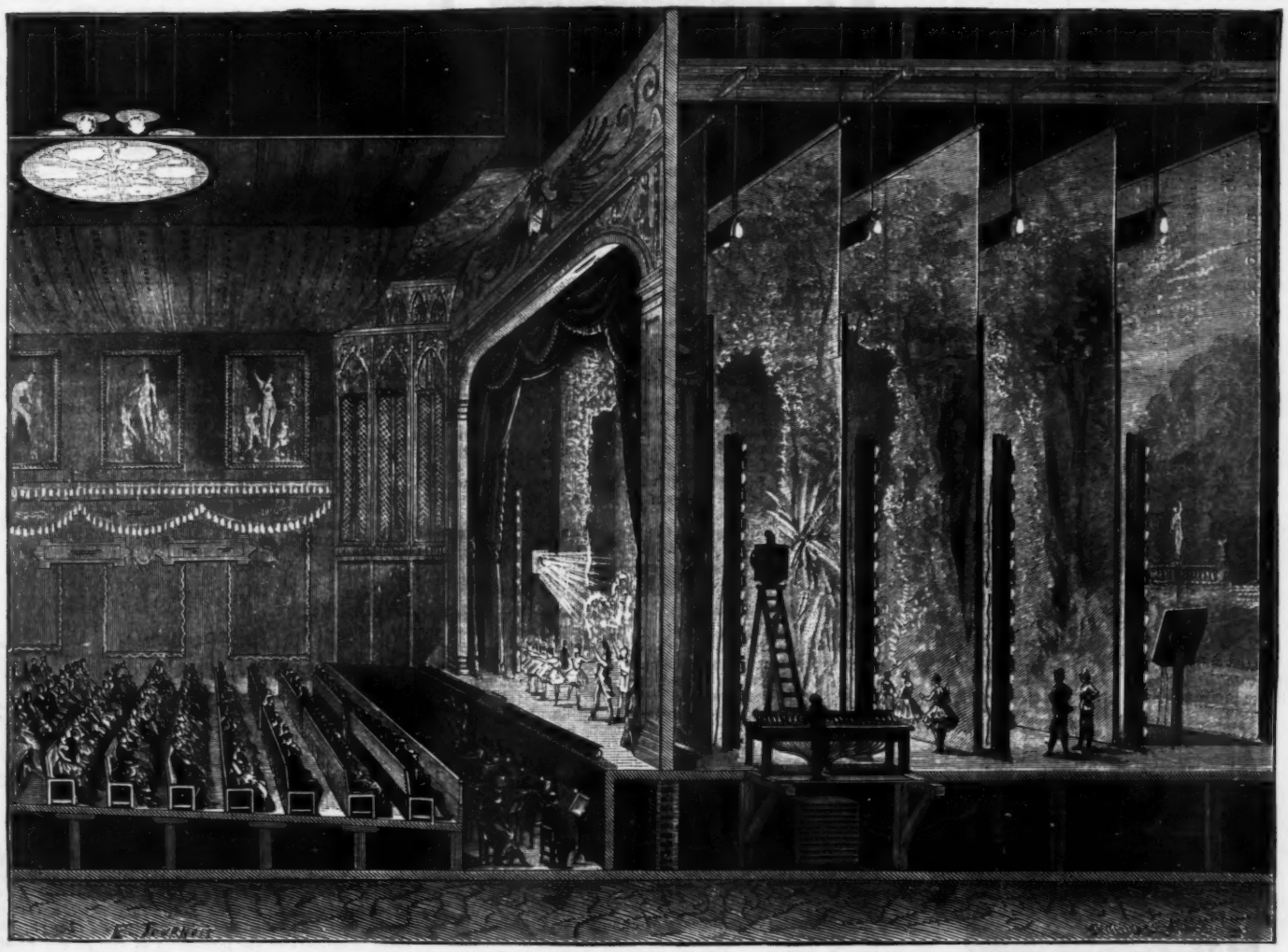


FIG. 6.—SECTION OF AUDITORIUM AND STAGE OF THE THEATER AT THE MUNICH EXHIBITION OF ELECTRICITY.

moved from an electric installation, and that increasing need of light that is making itself felt in theaters as well as in all public places, and in our very dwellings. This growing need, which to-day is an undisputed one, is a consequence of the ever increasing progression that follows a wealth of

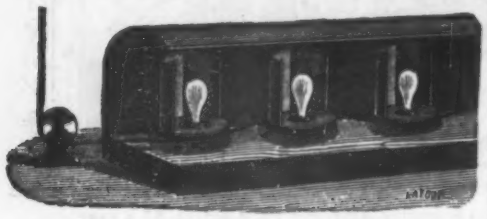


FIG. 1.

decoration. If we increase gildings, paintings, and ornaments of all sorts, we must inevitably have more light to set them off, and theaters will forcedly be subject to this law.

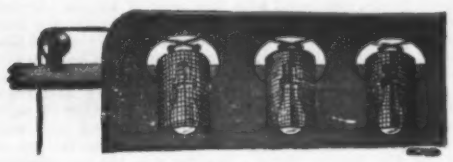


FIG. 2.

But, in these establishments, if the increase in light is obtained by gas, we shall see all the inconveniences of the latter increased to a grievous extent. By adopting electric

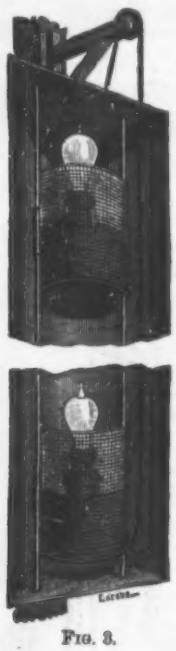


FIG. 3.

lighting, on the contrary, we shall increase the light while at the same time we suppress such inconveniences.

Despite the precautions taken, fires in theaters lighted by

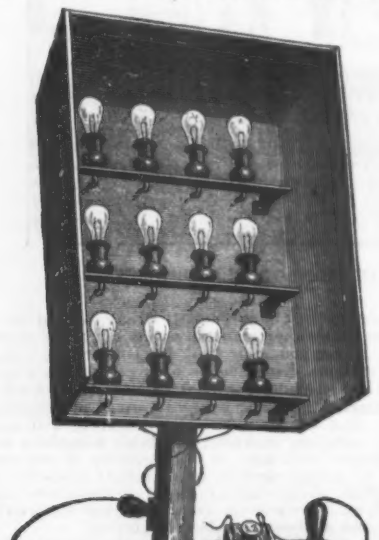


FIG. 4.

gas are still frequent. It was but very recently that the Tours theater was destroyed by fire, and if the putting of electric lamps into these places of amusement is to be countenanced by any one, it certainly should be by the theatric commission charged with examining whether sufficient preventive precautions have been taken.

With electric lamps, in fact, fire risks are absolutely *nil* when the installation has been well made.

With incandescent lamps, danger cannot proceed from the destruction of a lamp, since that would be at once followed by a breaking of the latter's circuit. It can only be caused by the fact that some conductor or other has been raised to incandescence through receiving too intense a current from some cause or another. But, in such a case, the danger may be entirely avoided by interposing fusible pieces at proper places, so that, if heating occurs, such pieces may be destroyed by fusion and the conductor never be raised to red heat.

With arc lamps the same precaution may be taken, although these may, on another hand, present a certain danger in case fragments of lighted carbon escape from them. The use of suitable globes, closed perfectly beneath, permits again of dispelling all fear on this score.

As for motors, these cannot be considered of themselves as a cause of danger, since they will usually be placed in a cellar or basement containing no combustible materials, and may in certain cases be put into a building separated from the theater.

It has been said that the gutta-percha and other analogous

FIG. 5.

materials with which conductors are covered constitute a danger in consequence of their great combustibility. This is, it seems to us, a point not worth dwelling upon. For the same reason we should have to suppress in theaters a large number of substances that serve for ornamentation or for putting a piece on the stage, and which are combustible to the same degree.

As regards danger of fire, then, there is no serious objection in the way of lighting theaters by electricity. On another hand, it is allowable to suppose that when the question shall have been better studied than it has been as yet the expense will not prove an obstacle. Indeed, the electric lighting of a theater requires a large number of incandescent lamps, and may, by that very fact, be effected under more economical conditions.

The gravest drawback will result, in many cases, from the difficulty of placing the current-generating machines, especially in theaters that are already built and in which a proper room has not been provided for the purpose. In new theaters there will be less difficulty as regards this, and it will be especially easy for the directors of these to enter on the path of progress. It will be for them to show the way, but there is every reason to believe that the rest will not be slow to follow.

For these details and for the illustrations we are indebted to our contemporary *La Lumière Electrique*.

BLEACHING BY ELECTRICITY.

THE memoir of Messrs. Naudin and Bidet upon the electrolysis of chloride of sodium having been published *in extenso* in the *Bulletin* of the Chemical Society of Paris, we extract from it an account of the laboratory experiments that were performed with a view to bleaching textile materials by this means.

Attempts to separate chlorine and sodium are not new, for we find evidences of them in patents taken out in France and foreign countries more than thirty years ago, but inventors have always encountered difficulties such as to make them regard the solution of the problem as impossible. In reality, this is because that, since the application of the Weldon processes to the chlorine industry, the low price of this agent has seemed to defy all competition. Calculation shows, in fact, that the quantity of electricity requisite to dissociate one equivalent of chloride of sodium actually costs more than the price of an equivalent quantity of chlorine and sodium (the latter reckoned as soda) prepared by the old processes.

Mr. Laurent Naudin has overcome the difficulty by applying, with modifications, the same method to the bleaching of textile materials that he did to the deodorizing of alcohol by electricity. Only, instead of trying, like his predecessors, to isolate the active principle of sea salt, he has devised an apparatus founded upon the principle of electrolyzing a solution of chloride of sodium (of sea water, for example), of forcing it, by means of a pump, upon the material to be bleached, of taking it up for electrolysis after the reaction, and of forcing it anew upon the textiles, and so on till the bleaching is completed. Mr. Naudin started from the fact that, since in every chemical operation nothing is lost and nothing created, the same quantity of chlorine might be made to serve indefinitely, taking into account, of course, those losses that are inherent to industrial manipulations. In fact, whatever be the theory of decoloration, as yet very obscure in its mechanism, chlorine in contact with organic matter is converted into an equivalent quantity of a chlorinated compound (hydrochloric acid, etc.) which is lost in the washings that succeed the principal operation, and which is capable of giving active chlorine through electrolysis.

Thus, at every operation there would no longer be but a small quantity of electrolyte to expend; the same chlorine would serve continuously as an intermedium to oxidation, and the cost of treatment would consequently be reduced.

It was in view of scientifically establishing a possibility of this idea and of determining the conditions of treatment on a large scale, that Messrs. Naudin and Bidet instituted a series of experiments upon the electrolysis of chloride of sodium.

The following are those that have a direct bearing upon the question under consideration. The authors first tried to study the course of the reaction in an apparatus so constructed as to separate the products found at the two poles.

For this purpose they employed two test-glasses, A A (Fig. 1), connected by a siphon, S, provided with a cock. Into these vessels dipped the two electrodes, P and N. As it is necessary after each test made at O and O′ for the analysis of the products to maintain the same electrolyzing surface, the rod of each electrode was made to slide by

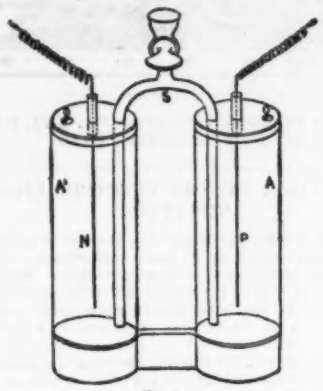


Fig. 1.

slight friction in the cork stoppers closing the aperture of each test-glass. The total surface of the two electrodes was 60 square centimeters. The current was furnished by three Daniell elements mounted in tension.

The results of a table giving a resumé of numerous experiments, and too lengthy to insert in this place, are expressed graphically in Fig. 2, and give occasion for the following remarks:

1. Starting from the fifth day, the quantity of chlorine in solution (Cl_s) remains constant. Starting from this mo

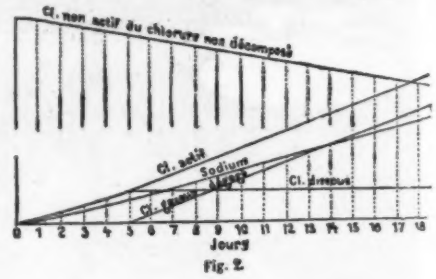


Fig. 2.

ment, in fact, the water being saturated, the chlorine becomes disengaged in measure as it is produced.

2. The quantities of chlorine under gaseous form (Cl_s) go on continuously increasing.

3. The total production of active chlorine is very small in view of the resistance offered by the siphon, S, that closes the circuit.

The quantitative analyses of sodium made at three equal periods during the experimentation show a perceptible correspondence with the theoretic quantities.

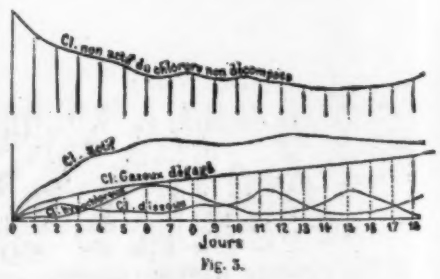

Cl. non actif du chlorure non décomposé
Cl. actif
Cl. Gazeux dégagé
Cl. hypochloreux
Cl. dissous
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Jours

Fig. 3.

Finally, the line of demarkation between the chlorine on the one hand and the soda on the other has kept up very sharply during the eighteen days, without any traces of hypochlorite having been seen, this being a certain evidence that there had been no mixture. This experiment, then, demonstrates the possibility of completely separating the chlorine from the soda.

A second experiment now gives a very clear idea of what takes place when the electrolysis of chloride of sodium is performed without separating the two electrodes by a partition, and following the operation, as above stated, for

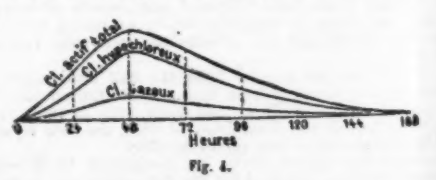


Fig. 4.

eighteen days. As regards the composition that the liquid takes, the results are expressed graphically in Fig. 3. We see here that, aside from the chlorine which is disengaged, and the disengagement of which is represented by a parabola, the liquid always composed of a mixture of chlorine and hypochlorite—a mixture well suited for the bleaching of fabrics.

In an electrolysis in all respects like this, but one in which the electrodes had been separated by a wooden frame that not only played the role of a support but also constituted an organic matter upon which the chlorine produced was capable of acting, some results were obtained that are shown in the curve in Fig. 4.

It will be seen that, at the end of seven days, the chemical reaction having got the start of the electrolytic phenomenon, all the active chlorine had disappeared as a consequence of its action upon the organic matter, and that the total inactive chlorine had become equal again to the total initial chlorine of the bath of chloride; that is to say, if the organic matter had not been present to continuously destroy the product formed by the current, there would have been found a liquid that was capable of giving the same results as the prior one.

Thus, then, is demonstrated the possibility of a rotation of chlorine with a feeble electromotive force.

As for practical results, these are now being obtained, and we think it may prove possible before long to give some details in regard to the subject.—*La Nature.*

THE AUTOMATIC FIRE EXTINGUISHER.

WE find the following account of the examination of the Grinnell automatic sprinkler by the officials of the Boston fire department, in a late issue of the *Evening Journal* of that city: "By invitation of Messrs. Rand, Avery & Co., a number of gentlemen, including Commissioner Fitzgerald, Chief Engineer Green, and other officers of the fire department, Messrs. Edward Atkinson, John C. Paige, James Swords, and others connected with insurance interests and representatives of the press, assembled shortly after noon to-day at the Franklin Building on Franklin Street, to witness an exhibition of the Grinnell automatic sprinkler system, consisting of sprinklers, air-pressure tank, with water supply and fire alarm all in combination. The sprinkler service in Messrs. Rand, Avery & Co.'s establishment consists of 421 sprinklers, located on the ceiling some 10 feet apart, and also in closets, stairways, elevators, and belt-boxes. Connected with the pipes on which these sprinklers are placed is a boiler-iron tank, two-thirds filled with water and one-third air, under about 60 pounds pressure to the square inch, which will discharge over 500 gallons of water, with a terminal pressure within the tank, when emptied, of from 10 to 15 pounds. Pressure on the entire system is readily maintained, as there is no leakage. Any loss of pressure is at once indicated by gauges in different parts of the building. Escape of water from one or more of the sprinkler-heads causes a 16-inch alarm gong on the office floor to be struck 96 blows within a period of six minutes. This air pressure and the alarm are the especial features in the system to which attention was called, and Messrs. Rand, Avery & Co. are the first to adopt them. The exhibition of the working of the system was made upon the roof of the establishment, where one of the sprinkler heads was melted by the heat caused by the burning of a single match. A steady and heavy shower of water over an area of more than 100 feet was the immediate result, while the sounding of a gong in one of the apartments below was distinctly heard. Ten sprinklers were opened, and the flood from the two continued without apparent abatement of the pressure for 15 or 20 minutes. The sprinkler system has for its object the extinguishing of fires in their incipiency, and in many cases has worked to the thorough satisfaction of those who have adopted it. It has been adopted in a large number of factories, and with the improvements which Mr. Grinnell has added will undoubtedly be still more largely adopted. An interesting fact stated by Mr. Atkinson to those present at the exhibition to-day is that at a recent fire in a cotton mill, the loss, which would almost certainly have been some $500,000, but for the presence of a system of automatic sprinklers in the buildings, will not exceed $15,000.

BRIDGE OVER THE YAZOO RIVER, FOR THE LOUISVILLE, NEW ORLEANS & TEXAS RAILROAD.

THE Yazoo River flows into the Mississippi, a few miles above Vicksburg. At the point where the bridge in question is being built, that is, twenty miles above its mouth, it has a depth at ordinary low water of 31 ft. and is subject to a rise of 50 feet.; being so near the Mississippi the height of water at the bridge is, of course, dependent in a great measure upon the condition of the larger stream. This circumstance makes the current in the Yazoo very capricious, it being sometimes very strong (when the Mississippi is low and the Yazoo high); at other times it is scarcely perceptible, or even has an up-stream tendency. The period of low water begins when the lower Mississippi subsides after the summer freshets; and, with the exception of possible local rises, the river remains comparatively low from late in the summer until about Christmas, occasionally until later.

In the valley of the lower Yazoo the prevalence of malaria makes it impracticable to execute any work until the excessive heat and sickness of summer are over. Thus the bridge building is by fever and flood hemmed into a period of but three or four months in the year during which work can be done. Added to this is the disadvantage of having to bring from the North men and machinery, and to depend upon the common labor of a set of fever stricken natives, who, however well they may possibly mean, have anything but a proper conception of time and the value of promises. So much for the country.

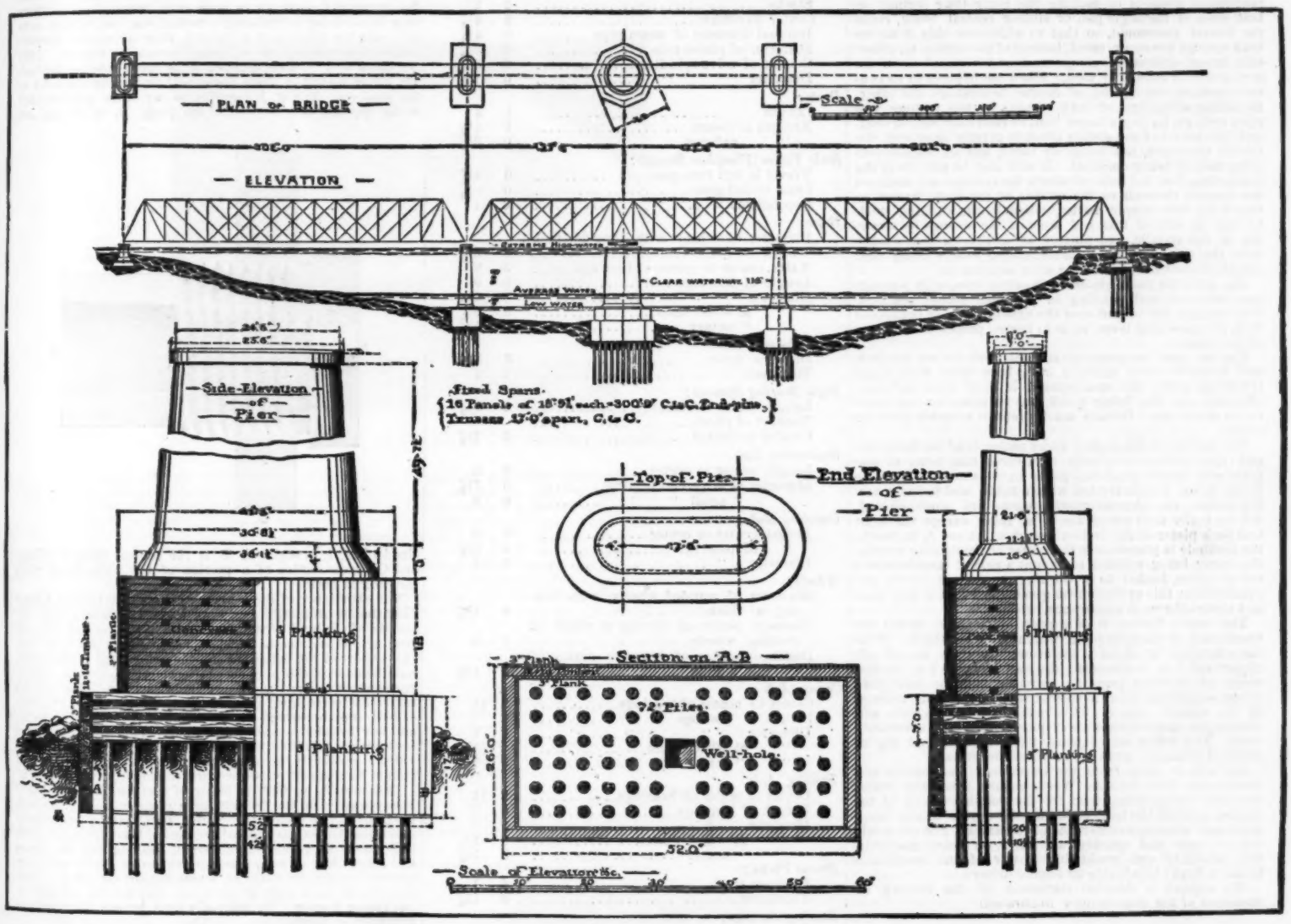
At the site of this bridge the banks and bottom of the Yazoo are made up of the regulation Mississippi River deposit, with, perhaps, a little more clay than is usually found on the bottom of the larger river. There were also occasional streaks of gravel met with in making the borings. No bed rock was found. This bottom is subject to scour, but to what extent could not be ascertained, as there were no existing bridge piers in the neighborhood to study.

The great depth of water at a flood stage, 81 ft., with occasional heavy drift flows and current, rendered a strong and hence heavy pier necessary. And as the piers would be necessarily expensive, it was advisable to reduce the number to a minimum and use long spans. Hence, with heavy piers and weighty superstructures, both indispensable conditions, the foundation had to support a great weight.

Pneumatic caissons would have been very heavy and were impracticable, because it was doubtful if they could be sunk to a depth where the material would have had a sufficient bearing capacity. Pneumatic cylinders were open to the same objection, though in a less degree, and their great height would have been objectionable, though not without precedent. But aside from these objections another kind of pier seemed better and much cheaper. The engineers consulted (Wm. Sooy Smith & Son, of Chicago), after a careful personal examination of the site, recommended the following plan, which is a combination of two well-known methods of building foundations, but so far as the writer knows, never before employed. It seemed to satisfy all the conditions of the case at a minimum cost, for all the material, except the cement, was afforded in abundance at the bridge site

The width of the river was about 900 ft., and it was decided to make two fixed spans of 302 ft. each and a draw of 275 ft., total length; thus requiring two abutment piers, a pivot, and two other stream piers. The three piers in the stream were to be built as follows:

Large pine or cypress piles were to be driven—100 for the pivot and 72 for each of the other two piers—to a depth of 30 or 40 ft. into the bottom. Pneumatic caissons were then to be built, floated over the piles (previously sawed off sufficiently low to permit this), and sunk until the top of the air chamber of the caissons should be level with the bottom of the river. At this level the piles were to be sawed off even and the caisson settled to a bearing upon them. The roofs of the caissons were to be of solid timber, 7 feet thick. Surmounting the roof, in the pivot pier and in that for one of the other two which was in the deepest water, was to be a crib-work, built *cob-house* fashion, dividing the space above the roof and up to a point 2 ft. below low water mark into compartments 5 ft. square, which were to be filled with concrete. From this point up, and in the case of the piers in shallower water directly from the roof up, the piers were to be monoliths of concrete, built by laying the concrete in a temporary wooden shell of the proper shape. Concrete possessed a great advantage in point of cost over masonry, there being no dimension stone available, while there was an abundance of excellent sand and stone for concrete close at hand.



NEW BRIDGE OVER THE YAZOO RIVER.

The object of using pneumatic caissons was twofold—it afforded a means of sawing off the piles at the river bottom and obtaining a perfect bearing upon them; and the sides of the caissons were to form a kind of sheathing or protection to the piles in case of scour. This latter, however, was to be prevented by mattresses and rip-rap about the piers.

The abutments were to be also of concrete, one of them to rest on piles. As navigation on the river is very limited, no protection for the draw has been planned, though one may be built eventually.

During the short working period of last year material was accumulated and a large portion of the work done before the high water caused its suspension. All but a few of the piles were driven for all the piers; one of the caissons was sunk and the concrete over it commenced; both of the other caissons were built, the two abutments started, and considerable other work done. With fair luck the work is expected to be completed and the superstructure, for which Clarke, Reeves & Co. have the contract, nearly erected during the coming working season.

The chief engineer of this work is Capt. John A. Grant. Wm. Sooy Smith & Son, of Chicago, are the consulting engineers.—*Engineering News.*

ENGLISH LOCOMOTIVE.

We illustrate a passenger engine used on the Glasgow and South-Western Railway, for working express trains between Glasgow and Carlisle. The passenger service during summer, in connection with the river steamers, is, says *Engineering*, not only of a very heavy description, but it is also required that good time be maintained, the average speed required with the express trains being forty miles per hour. The work for some years was done by engines with cylinders 17 in. in diameter by 24 in. stroke, and having four coupled wheels 6 ft. in diameter, but as the four-wheel carriages got replaced with a heavier and better class with six wheels, in increased numbers, these engines became unfit to meet the work, and have been replaced with the class we now illustrate.

These engines, which have been constructed from the designs of Mr. Hugh Smellie, the locomotive superintendent of the Glasgow and South-Western Railway, have cylinders 18¼ in. in diameter by 26 in. stroke, and the mean diameter of the four-coupled wheels being 6 ft., the tractive force is $\frac{18{\cdot}25^2 \times 26}{72}$ = 120 lb. for each pound of effective pressure per square inch on the pistons. It will thus be seen that they are of the most powerful class of passenger locomotives in the kingdom. The front of the engine is carried on a four-wheel bogie, found to be of special benefit on sections of the line where curves are numerous, and as will be seen from the engravings side spring-cushion slides are used, which prevent any tendency to roll. A special arrangement of side springs is also used to control the lateral play; this arrangement consists in making the controlling springs on both sides of the bogie pin, or sliding central block, resist the lateral movement, so that to whichever side it moves both springs are compressed, instead of the springs on either side being alternately compressed and released, as in the arrangements ordinarily used. When the bogie is in its central position, one spring, of course, neutralizes the other. By taking advantage of both springs in this manner, less rigid springs, having a larger limit of elasticity, can be used, and the travel of the sliding block is greatly improved, the rise in resistance not being so rapid, and all tendency to jerky motion being removed. It will also be seen from the engravings that the rods on which the springs are mounted are carried through to the outside of the bogie frames, so that it is a very simple matter, when in the running shed, to take up loss or tear and wear of the springs by screwing in the spindle, and putting an additional iron washer next the side frame, a suitable locking washer being used outside to prevent unscrewing after adjustment.

The axles for the bogie are of Bowling iron, with journals case-hardened, and running in phosphor-bronze bearings. The springs are placed over the axle-boxes, and connected with an equalizing lever, so as to insure proper distribution of the weight.

For the past ten years all engines built for the Glasgow and South-Western Railway have been fitted with steam reversing gear; the arrangement is very neat and most effective, not only being quick, but reducing manual labor to the minimum. Drivers much prefer it to either lever or screw.

The boiler of the engine under notice is of the flush topped type, built telescopically, each barrel ring being of one plate with longitudinal butt joints in the steam space, these joints being double-riveted with outside and inside covering strips; the circumferential seams are single-riveted. All the boiler shell plates are ⅛ in. thick, except the front and back plates of the firebox casing, which are $\frac{7}{16}$ in. thick; the manhole is placed over the center of the driving wheels, the cover being utilized to mount a pair of Ramsbottom's safety valves, loaded to a working pressure of 140 lb. per square inch; this arrangement gives the whole a very neat and straightforward appearance.

The inside firebox is of copper ½ in. thick, except the upper part of the tube plate, which is ⅜ in. thick. With the exception of those in the crown, the stays are of soft copper rod 1 in. in diameter; the roof stays are 1 in. in diameter, of Bowling iron, the two rows next the tube plate being supported from a special soft steel casting, riveted to the outside casing. This makes a very effective and simple job, dispensing with all joints, pins, etc., commonly used. The tubes are of brass, 195 in number and 1¾ in. external diameter, arranged in horizontal rows.

As will be seen from the engravings, the engines and tenders are fitted with the Westinghouse automatic brake, cast-iron blocks being used for the coupled wheels of the engine, and all the tender wheels, the engine blocks being kept well below the center line of the axles. For the working of large and quickly run trains, on heavy gradients, the reliability and graduating power of the continuous brake is found invaluable by engine drivers.

We append a detailed statement of the leading dimensions of the engines now illustrated:

Leading Dimensions of Bogie Passenger Engine.

	ft.	in.
Boiler:		
Length	10	5¾
Diameter outside smallest plate	4	2
Height from the top of bars to crown at back	5	0⅛
Thickness of plates	0	0½
" tube plate ⅜ in. at tubes, ⅛ in. below		
Distance between crown of inside box and shell	1	5
Number of crown stays	104	
Area of firegrate	16	sq. ft.
Surface of firebox	101	"
Tubes:	ft.	in.
Length	10	11⅛
Thickness, B.W.G. 11 and 13		
Diameter outside	0	1¾
Number 195		
Outside heating surface	964	sq. ft.
Proportions of Boilers:		
Total heating surface	1065	"
Flue area through tubes	2·4	
Ratio of grate surface to total heating surface	1 : 66·56	
Ratio of flue area through tubes to grate area	1 : 6·67	
Smokebox:	ft.	in.
Length outside	2	9⅛
Breadth	4	10¾
Diameter of door	3	11
Thickness of plates—front, ⅝ inch; sides, $\frac{7}{16}$ inch.		
Chimney:		
Height from rail	13	0
Diameter at top inside	1	5
" " bottom "	1	4
Cylinders (inclined):		
Diameter	1	6¼
Stroke	2	2
Center to center	2	4½
Internal diameter of steam pipe	0	4¼
Diameter of piston rods	0	2⅜
Centers of valve spindles	0	3⅛
Diameter " "	0	1⅜
Ports:		
Length	1	4
Breadth of steam	0	1⅜
" exhaust	0	3¼
Slide Valves (Phosphor Bronze):		
Travel in full fore gear	0	4⅜
Lead in full gear	0	0⅛
Lap outside	0	1
Bogie:		
Diameter of wheels with tires 2¾ inch thick	3	0⅛
Axles, center to center of bearings	3	9
Length of bearings	0	9
Diameter "	0	5⅛
" at wheel seats	0	6¾
" " center	0	5¾
Bogie Frame Plates:		
Distance apart	3	3¼
Thickness	0	1
Bogie Bearing Springs:		
Length center to center	2	0½
Number of plates 11		
Camber unloaded	0	2½
Connecting Rods:		
Length center to center	6	0
Diameter of large end bearing	0	7⅛
" " small " "	0	3
Coupling Rods:		
Length center to center	8	3
" of pins	0	3⅝
Diameter "	0	4
Wheels:		
Diameter of coupled wheels, with tires 2¾ in. thick	6	1⅛
Distance center of driving to center of trailing wheels	8	8
Distance center of bogie to center of driving wheels	10	1⅛
Crank Axle:		
Center to center of bearings	3	11
Length of bearings	0	7
Diameter "	0	7
" at wheel seats	0	8⅛
" " center	0	7
Trailing Axle:		
Center to center of bearings	3	11
Length of bearings	0	7
Diameter "	0	7
" at wheel seats	0	8½
" " center	0	7¼
Frame Plates:		
Distance apart	4	1
Thickness	0	1¼
Bearing Springs:		
Length center to center	3	0½
Number of plates 14		
Camber unloaded	0	4⅛

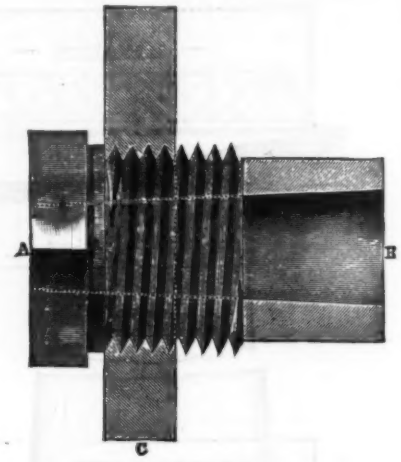
Weight of Engine in Working Order:	tons	cwt.
Bogie end	13	15
Driving wheels	15	0
Trailing	12	15
Total	41	10

FUSIBLE PLUGS.

A FUSIBLE plug is a composition shell filled with brass, tin, lead, or some suitable alloy, intended to be used as a safeguard against a class of disasters caused by low water. Fusible plugs are variously placed, according to the type of boiler in which they are used; the idea being to place them upon the highest point of the fire line. Their operation is as follows: So long as water of ordinary temperature is in contact with the plug it remains intact, but if uncovered by a deficiency of water the filling melts before the boiler can be dangerously overheated, while the discharge of steam through the aperture of the plug gives a warning of impending danger, and slightly reduces the pressure within the boiler.

The shell for fusible plugs should be made of hard brass that will insure durability and admit of a proper finish with a clean cut thread; and substantial hexagonal head, made stout and strong, to withstand frequent removal and replacing for examination; and refilling when necessary. The cored holes for the fusible filling are variously made by different manufacturers, some being straight, others straight with a conical head, while others again are bell-mouthed.

The straight ones we think are insecure, with a constant liability to fuse in and out of season. Those with straight bore and conical head are better if the countersink part forming conical head is properly done, while the bell-mouthed ones present a weak section about the head, so that if the plug is set fast in the boiler-head, as it is apt to be after one or two years' use, it will be almost impossible to get it out without such distortion as will prevent its further use. Therefore, while we would recommend every one who uses fusible plugs to have one or more extra ones on hand so there may be no delay in replacing a melted one, we would only advocate the use of such a formed plug as would promise sufficient durability to withstand several refillings. This we think may be accomplished if the cored hole for the fusible filling should be made about half an inch in diameter at the head end, A, Fig. 1, tapering to say three quarter inch at the opposite end, or point of the plug, B, as shown full



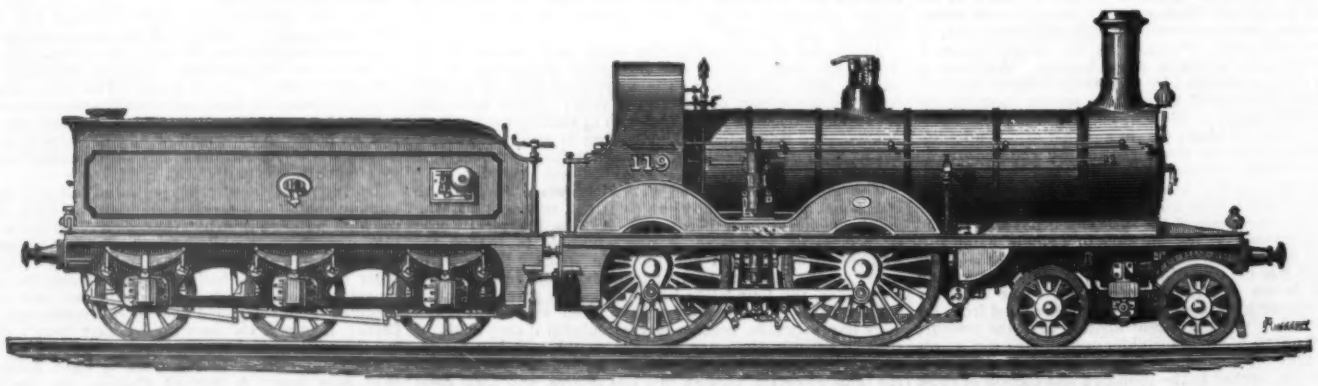
size in Fig. 1, in which A B is the conical shaped filling, and C a cross section of a portion of the boiler-head with the plug in position.

The experience of the company causes it to favor a longer plug than is ordinarily used—one about two inches long exclusive of the head of the plug, with a projection not exceeding one and one-half inches, nor less than one inch into the interior of the boiler beyond the boiler-head. The external diameter of this plug should be about $1\frac{7}{16}$ inches, which corresponds to the size of an inch pipe-tap. The thread need only be cut upon half the length of the plug; the other half may be turned down to about $1\frac{3}{16}$ inches diameter and not threaded—as shown in figure. This pattern we have found more desirable than the short ones commonly provided; evidently because while surrounded by water it cannot be treated to a temperature sufficiently high to melt it.

Occasionally we find the filling of that fusible plug badly honeycombed on the fire side for a distance nearly through the head of the boiler, the fusible part having apparently melted in the ordinary use of the boiler, there being no other indications of overheating apparent, leaving but the dross and a light film of good material next to the water side. In some externally fired boilers, where the fusible plug is tapped into the back head of the boiler, they last for years without giving trouble. In internally fired boilers they are not generally so durable.

The National Boiler Insurance Company, of England, who own a patent for what appears to be a very meritorious fusible plug, which they recommend for all boilers under their inspection, do not consider a plug reliable for a period exceeding two years without refilling. It is generally believed by engineers that after a year's service the ordinary fusible plug cannot be depended upon to fuse at a low temperature, owing possibly to changes which occur in the character of the alloy.

Banca tin is the filling recommended by the United States



PASSENGER LOCOMOTIVE, GLASGOW AND SOUTH-WESTERN RAILWAY.

Engineers, and we believe it to be as reliable as most of the alloys. Of course the purity of the article determines its usefulness for this purpose. We have a plug that melted inside of two weeks after being put in service, as also did several others of the same manufacture, under like circumstances previously, there being an ample quantity of water in every case, and no unusual disturbance noticed within the boiler. The melting was attributed to some peculiarity in the composition of the alloy—apparently such as to cause it to fuse at a much lower temperature than it should have done.

The law of Massachusetts requires a fusible plug upon all boilers, as also does the municipal law of several cities. The rules of the United States Steamboat Inspection service provide as follows:

"Rule 31. All steamers shall have inserted in their boilers plugs of Banca tin at least one-half inch in diameter at the smallest end of the internal opening, in the following manner, to wit: Cylinder boilers with flues shall have one plug inserted in one flue of each boiler, and also one plug inserted in the flue of each boiler from the inside, immediately before the fire line, and not less than four feet from the forward end of the boilers. All fire-box boilers shall have one plug inserted in the corner of the back connections, or in the highest fire service of the boiler. These plugs, in external diameter, must correspond in size to a one-inch gas or steam pipe screw tap."—*The Locomotive.*

THE NEW POCKET REVOLVER.

Most of the weapons called revolvers that have hitherto been constructed are not very convenient and do not come well into the hand. Moreover, only a limited number of shots can be fired with them, owing to their small size. The result is

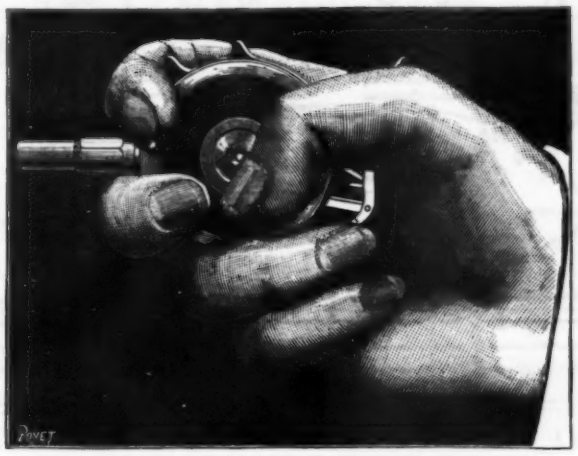


FIG. 5.—MODE OF USING TURBIAUX'S POCKET REVOLVER.

that the arm becomes a danger for him who uses it. If the adversary, in fact, grasps the hand of the person who is firing, he becomes the stronger of the two, and removes the weapon with all the more facility, in that it can be held with two fingers only. If in order to overcome such inconveniences a revolver be made which fits well in the hand, its dimensions become too large to allow it to be put even into the pocket of an overcoat. Mr. Turbiaux has got over the difficulty through an ingenious arrangement which we shall now describe, and one which differs completely in form, simplicity, and compactness from anything that has hitherto been made.

The size of this new pocket revolver is about that of an ordinary watch. In the apparatus figured we have represented a central fire, forced ball, ten-shooter, having a rifled barrel and a range that is relatively long as compared with its small dimensions. It should be understood that the quantity of projectiles employed is not absolute, and that Mr. Turbiaux can equally employ either central or rim-fire cartridges, and those of various calibers. The small weapon that we are describing can be put into the vest pocket as easily as a watch, and without causing any inconvenience. It is completely inclosed within the hand (Fig. 5), the end of the barrel alone extending beyond the fingers, so that it is impossible for any adversary to remove it. This revolver may also serve for giving a blow of the fist, and will prove a terrible weapon in the hands of him who holds it, if after exhausting his ammunition he has not vanquished his enemy. Mr. Turbiaux himself describes his revolver as follows:

"A box, A (Figs. 1 and 2), of steel, circular in form, carries at its upper part a threaded shoulder to which may be screwed barrels of different lengths, according to requirements or the laws of each country. On each side of the barrel, I provide the box with lugs, B, to serve as bearing points for the fingers. In the center of the box there is a fixed ring, C, which serves as a breach, and which is provided with an aperture at its center and in the axis of the barrel, through which passes the hammer. At G there is a knuckle on which is mounted the trigger, H. Two mortises formed in the bottom of the box permit the two rods, D and E (Fig. 1), to pass.

"The rod, E, communicates motion to the hammer, and D gives the motion that carries along the magazine, K. It will be seen that the rod, D, consists of a stiff, curved part which slides in a curved groove in the bottom of the box, and of a flexible part or spring, F, which, at a given moment, enters the depression, L, in the magazine, in order to cause it to revolve one division, and then slides over it where there is no longer any pressure on the trigger.

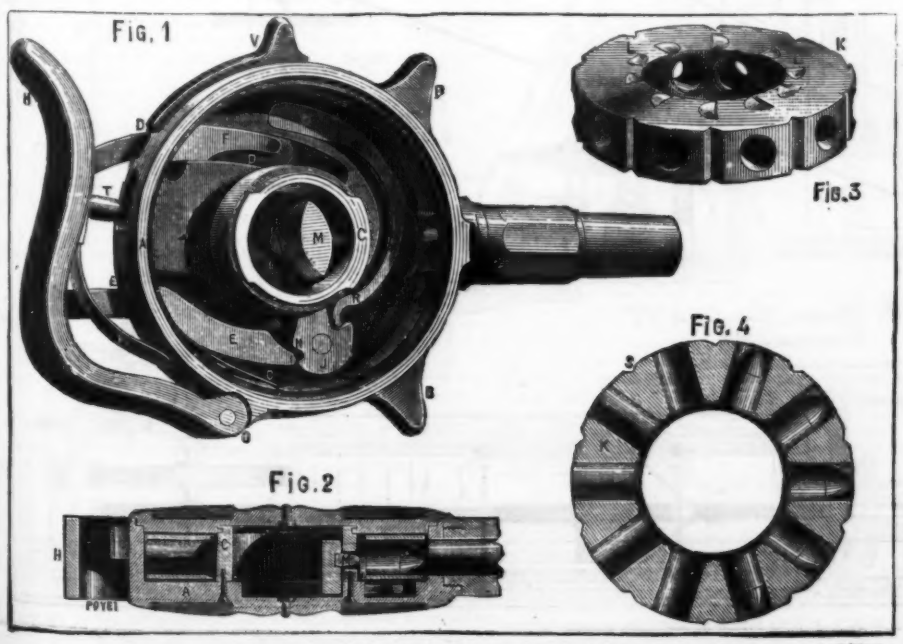
"*Firing.*—If, on grasping the box, A, in the hand, and taking as a bearing point the lugs, B, the trigger, H, be pressed, the lever, E, will set in motion the nut, J, which carries at its other extremity an ogive shaped mass (cock) that moves in the interior of the breach-ring and carries the hammer, M. At a certain point of its travel, the extremity of the lever, E, rests on the nut, J, and causes the hammer to tilt. However, at a given moment, the extremity, I, escapes from the nut, through the action of the projection, N, but the spring, E, always keeps its extremity engaged with the nut, so that, as soon as the part, I, has escaped therefrom, the spring, R, will act upon the hammer and cause it to strike forcibly against the priming of the projectile. A small spring, O, pulls back the lever, which is engaged with the nut, J, in measure as the trigger resumes its prior position through the action of the spring, R.

"*The Magazine.*—The magazine, which is of steel, is of very peculiar construction and has the form of a truncato-conical ring (Figs. 3 and 4). It carries at its periphery as many cartridge chambers as the space will admit of, and which are provided with internal counter sinks designed for holding the cartridges by their rims. Between each chamber and upon the flat surface of the ring there is a nail-shaped depression, L, with which engages the spring of the piece, D, and serves to thrust the magazine forward one division for each shot to be fired. But this would not have sufficed to secure a perfect parallelism of the chamber with the barrel had I not taken the precaution to provide the outer circumference of the cartridge ring with ratchet-tooth shaped notches, whose utility I shall explain. The trigger carries a rod, T, whose extremity has the same shape as the notches on the circumference of the magazine, and which, at every shot, traverses the box and engages with a notch, thus securing a perfect correspondence of the cartridge chamber with the barrel, and preventing in this way all waste of gas. The entire mechanism having been placed in the box, I close the latter by a cover provided with a bayonet catch, which is opened when it is desired to reload or inspect the weapon.

"The truncato-conical form of the magazine is very important as regards the possibility of easily disengaging it, for, were it perfectly cylindrical externally and internally, it would prove very difficult to take it out."

Mr. Turbiaux has placed on the edge of his box a sliding safety-bolt, V, which, when pushed toward the trigger, locks the latter and prevents the weapon from going off accidentally, even when it is pressed upon. Between this device and the trigger there is left sufficient play for a disengagement of the hammer in order to facilitate the removal of the barrel.

The revolver is made ready for use as follows: After pushing the safety-bolt toward the trigger, and taking off the cover, it is only necessary to turn the revolver over in order to have the magazine drop into the hand. The cartridges are then introduced from the center, the magazine is put back in place, the cover is put on, and then, after pushing the safety catch toward the barrel, the weapon is ready for use. The inventor calls this revolver the "Protector."—*La Nature.*



FIGS. 1 TO 4.—TURBIAUX'S NEW POCKET REVOLVER. (Actual Size.)

THE INCLINED PLANE AND ELEVATING APPARATUS AT BRIANÇON.

THE large inclined plane that we shall examine in this article was constructed in 1876, and has been in operation since that time. It was used in the first place for raising to the proper elevation the materials necessary for the building of Fort de la Croix, at Briançon. After the completion of this work, the plane, which had worked to the entire satisfaction of the contractors (Messrs. Jacques & Anguila), was purchased by the engineering department of the army, and used for provisioning the fort.

The height to which the materials have to be raised is 642 meters for a horizontal length of 1,250 meters, thus giving a mean incline of 50 to 100.

The fort is situated on the top of a mountain, shaped like a loaf of sugar. The upper point, which is of very hard rock, was leveled off in order to establish a platform thereon. Blasting had to be performed in order to detach the blocks, and, to prevent accidents, an arched way had to be constructed for protecting the upper part of the inclined plane, as shown in Fig. 5. The profile of the inclined plane is intersected at different points along its length by a circular road which runs up the mountain. One of the conditions to be fulfilled was to cause the plane, at the different crossings, to pass four meters over the roadway so as to give free passage to carts. Such a necessity obliged the builders to construct at every intersection a high framework that abruptly broke the profile and created irregular slopes. These irregularities, joined with those of the ground, were one of the causes that led to the adoption of the inclined plane such as we now have it.

The dominant idea of the project was to have the line follow all the sinuosities of the ground as far as possible, so as to avoid the expense of framework and of the excavating that would have had to be done had a regular grade been adhered to. Such an idea could only be realized with an endless cable for drawing the cars in both directions, and in suppressing by some means the irregularities in the running of the latter due to the different grades. Here arose the great difficulty. The mechanism (steam-engine and windlass) could not, for many reasons, be placed at the upper extremity of the inclined plane. The permanent danger from projections due to blasts, the absolute lack of water and fuel at this point, and the need of utilizing the same motor for different purposes, such as mixing mortar, sawing, etc., all indicated that it should be placed below. The problem consisted then in the discovering whether it would be possible to raise, over an inclined plane 650 meters in height and about 1,400 meters in length, and provided with a double track, a car loaded below, and this by means of an endless cable 3,000 meters in length passing over the ascending track and running around guide pulleys placed at the upper part of the plane in order to descend upon the other track.

This problem was considered infeasible by a large number of engineers, and the solution of it seemed practical to Mr. Megy only after a careful examination of the profile of the ground. This profile, although very irregular, perceptibly partakes, as a whole, of the form of a branch of a parabola whose summit passes through the lower starting-point of the inclined plane. The ordinates or heights increase progressively, and the tangents or gradients corresponding to such heights vary from 0 to 38. The tractive stress upon the car therefore increases progressively. Such stress, which is almost *nil* at starting, reaches its maximum at the top of the plane. By causing the starting of a full car below to coincide with the return of an empty one above, whose nearly vertical action is transmuted in great part into motive traction upon the cable, there is diminished to a considerable degree the enormous stress that would have been exerted upon the windlass and cable, and the latter is protected from these limited tractions that it could not long have resisted had the gradient been constant. The effective load placed upon the car should reach 1,250 kilos.

The dead weight of the car is about 750 kilos. The total maximum weight to be hauled is therefore about 2,000 kilos. The cable, being an endless one, balances itself exactly and offers only such resistances to friction as are due to its weight, the latter being further notably diminished in consequence of the parabolic form of the profile of the ground, as we shall see.

Upon starting, the loaded car moves upon a horizontal, and the theoretic stress is *nil*. At the first lower gradient, which is 0·35 m. per meter, the theoretic resistance is:

$$2{,}000 \times 0{\cdot}35 = 700 \text{ kilos};$$

and the motive action of the empty car acting on a gradient of 0·67 m. per meter is:

$$750 \times 0{\cdot}67 = 502{\cdot}5 \text{ kilos.}$$

The difference in traction is only about 200 kilogrammes, and the windlass has to overcome this, plus friction. In measure as the loaded car ascends, the traction becomes greater, but the distance in transmission diminishes. Toward the end of its travel the traction due to the weight is:

$$2{,}000 \times 0{\cdot}67 = 1{,}340 \text{ kilos;}$$

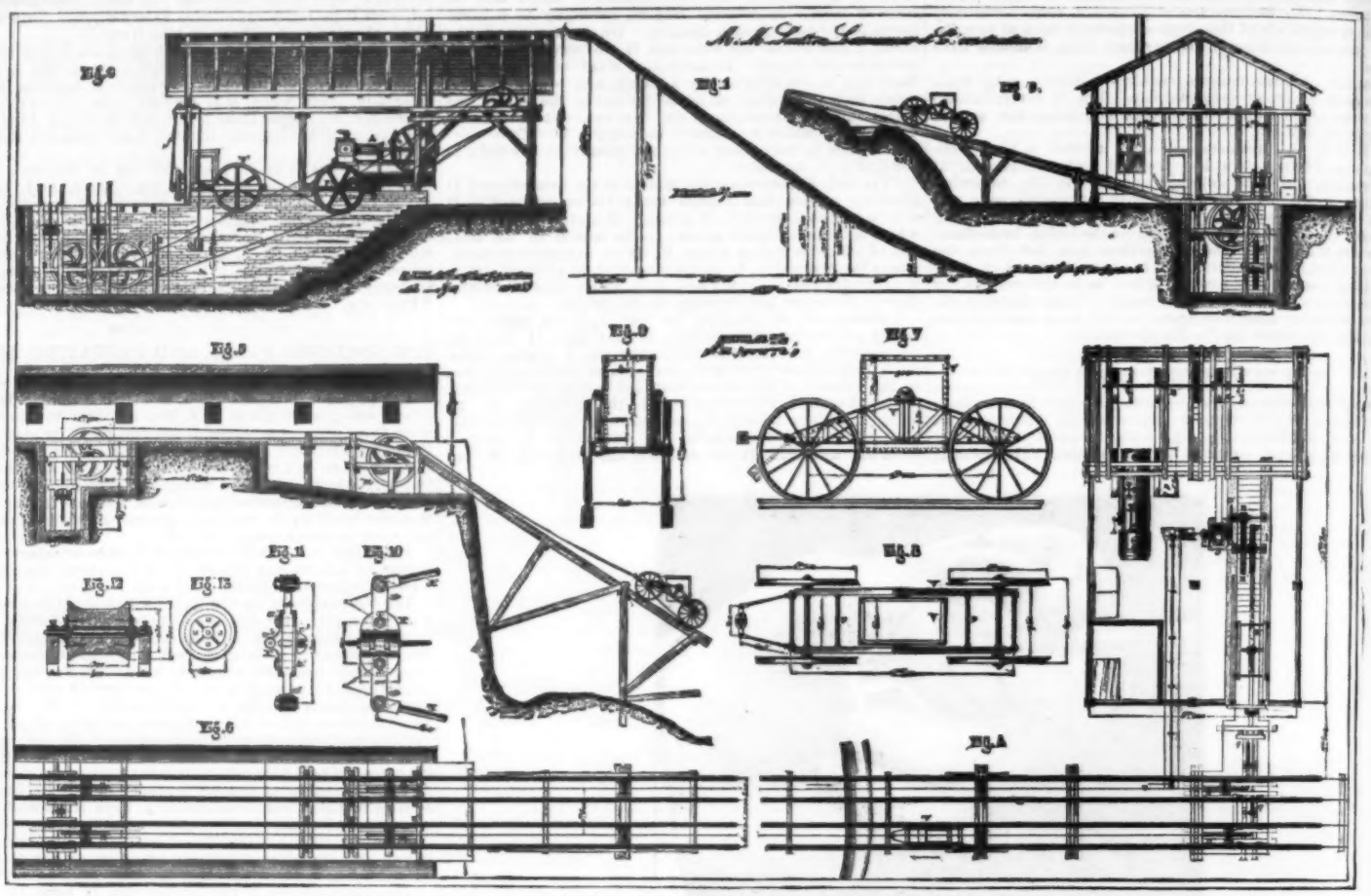
and without compensation, since at this moment the empty car is running over the horizontal below.

This traction directed in a line with the cable to the upper end and the horizontal motive traction at the lower end produce upon the cable the effect that horizontal and inclined

fractions do upon a suspension bridge, that is to say, they balance the weight. So, while running, the cable detaches itself from hollows in the roadway, tends to take the form of a parabola, and rests only partially upon certain rollers situated at the apices of the angles in the road or ground. Thus, as may be seen, this fortunate peculiarity in the form of the ground singularly removes all difficulties, and has permitted of a full solution of the problem.

At the time the fort was building, the service was so organized as to always have an empty car balance a full one. The arrival of the empty car below, which corresponded with that of a full one above, caused an automatic stoppage of the windlass, although the motor always continued running. During this stoppage the changing of the cars was affected, the coupling was always performed at the same limited points of the plane, and the arrivals above and below were always simultaneous. A telegraph station was established at each extreme point, and the signal for starting was given at the top by a bell. A simple maneuver of the gear-lever caused the car to start, without shock to the mechanism or cable.

pulleys over which the cable passes at the summit, near the fort. The details of the car are shown in Figs. 7 to 11. In Figs. 14 and 15 are shown on a larger scale (1 to 20) the details of the transmission, in plan and elevation, at the foot of the mountain. The steam engine, A, of 25 H. P., runs at a constant speed and gives motion to an intermediate



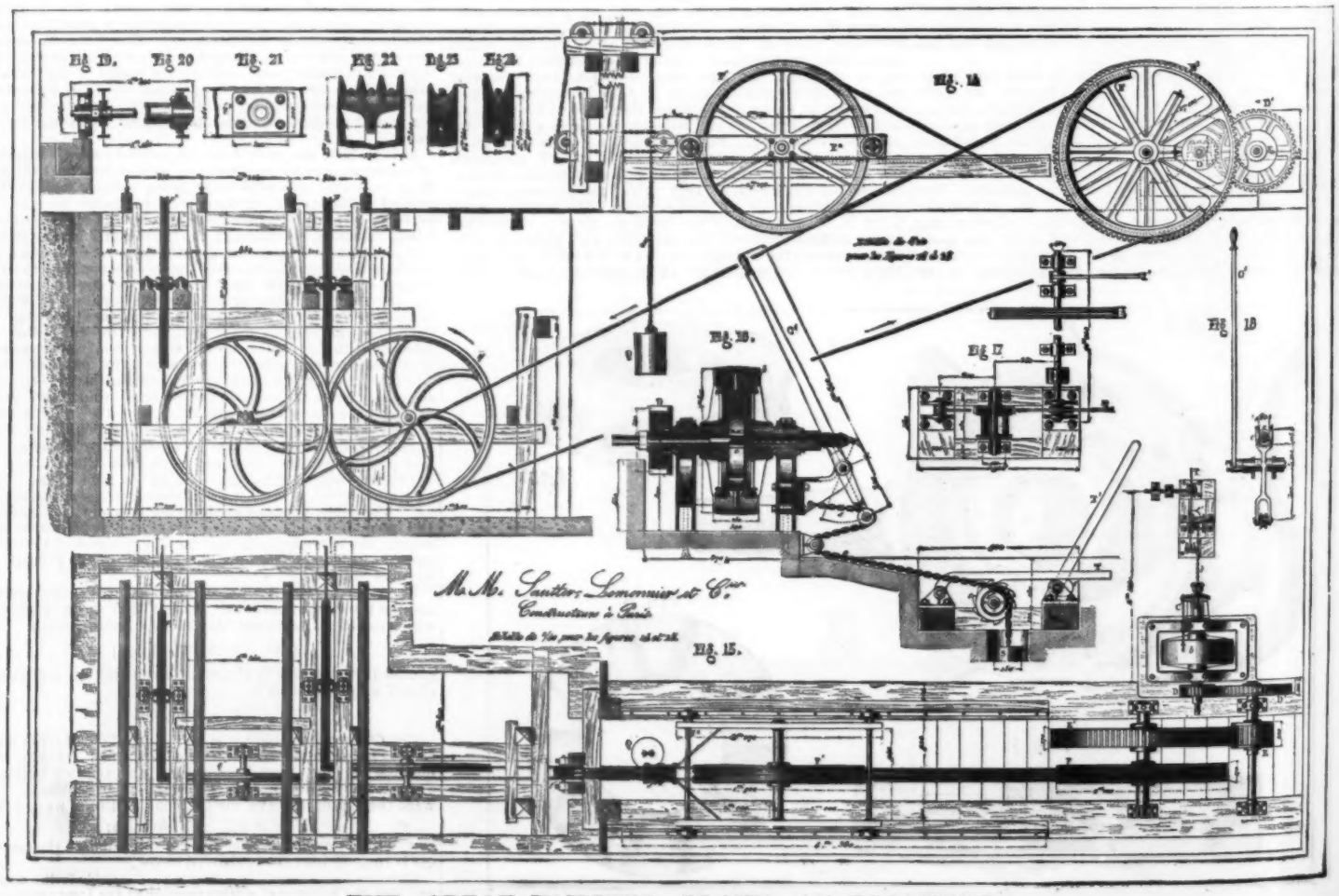
THE GREAT INCLINED PLANE AT BRIANCON.

DESCRIPTION OF THE INCLINED PLANE.

The profile of the mountain is shown in Fig. 1, on a scale of 1 to 10,000.

The installation of the motor, windlass, and starting gear, which, as we have said, are placed at the foot of the mountain, is represented in elevation and plan in Figs. 2, 3, and 4, on a scale of 1 to 150.

Figs. 5 and 6 represent, likewise in plan and elevation, the shafting, B, designed to actuate the different machine tools. Upon this shafting is mounted a pulley, *a*, which transmits a continuous motion to the pulley, *b*, of the starting gear. This pulley, which is represented in section in Fig. 16, is mounted loosely upon the coupling-box, C, to which the spring of the starting gear is fixed. This spring is freed by means of a movable tube, *c*, which carries the tightening chain, and which is provided at its extremity with a socket controlled by a forked lever, C'. In the position shown in



THE GREAT INCLINED PLANE AT BRIANCON.

the figure the spring has been left to itself and is uncoiled, the mechanism is thrown into gear, and the pinion, D, on the coupling box is transmitting motion to the cable through the intermedium of the wheels, D', E, and E', of the channeled pulleys, F and F'. On throwing the mechanism into gear, that is to say, on shoving the lever, C', into the position shown in the figure, the chain, *s*, which passes over the small pulley, *s'*, and holds the counterpoise, S, is acted upon at the same time. This counterpoise is held by a ratchet, *t*, which engages with a catch on the gear lever, T. So long as the mechanism is in gear the loaded car ascends and the empty one descends. When the latter has reached the lower landing place, it strikes against the automatic stopping lever, T', which revolves around its axis and actuates the cam, *t*, which lifts the lever, T. As soon as the catch is released, the counterpoise acts upon the chain, *s*, and this tightens up the spring. The whole mechanism is then instantaneously thrown out of gear and becomes immovable. Every time a car is started it is necessary to throw the brake into gear, and owing to this fact the counterpoise is wound up and ready to act. Nevertheless, it is optional whether the speed shall be moderated, or the car stopped for a moment, by causing the counterpoise to act or by throwing the machinery out of gear by hand, through the maneuvering lever, C'. For a longer stoppage the counterpoise is disengaged by means of the levers, T or T', according as the operator stands close to the gearing or near the track.

The cars, which are represented in detail in Figs. 7, 8, and 9, are each formed of a box, V, resting through the intermedium of trunnions upon two frames, V', composed of angle and flat irons. These frames, which are connected and held parallel at 0·54 m. apart by means of cross pieces, *v*, are mounted upon four wheels, v^1, 1·9 m. in diameter. The trunnions are placed over the center of gravity, so that the box shall always assume a vertical position whatever be the inclination of the plane, thus allowing of their being used for carrying up water, mortar, sand, etc.

To the extremities of the front cross pieces of the car are connected two drag bars, which we have represented in detail on a scale of $\frac{1}{10}$ in Figs. 10 and 11. This coupling consists of two small rods, *x*, jointed with the extremities of the bars, X, and connected with each other by two superposed plates, X^1, between which they are held by means of the bolts, x^1. The upper plate, X^1, is forged with two prominences that are traversed by the axis, x^2, around which pivot the two pendent jaws, x^3. These latter pass freely into two apertures in the plates, X^1, and tend to approach each other through the extremities of the rods, *x*, that have been made eccentric with respect to the axes of articulation, x^3. To bring about such approach it is only necessary to exert a traction upon the coupling—an action which is effected automatically in consequence of the adherence of the cable which passes between the leather lined jaws. The endless cable, which is 3,000 meters in total length, is of steel, and 18 mm. in diameter. Its weight is 1·2 kilogrammes per running meter, thus giving a total weight of 3,600 kilogrammes. Its absolute resistance is about 13,000 kilogrammes, and its working resistance may be carried to about 2,000 kilogrammes. It rests upon rollers distributed half of them upon the ascending and half upon the descending track, at variable distances from each other. These rollers, which are represented in detail in Figs. 12 and 13, are of wood and are 230 mm. in diameter.

The velocity of the cable is regulated at about 1·5 m. per second, and the mean power developed is about that of fifteen horses, this corresponding to a mean traction of 750 kilogrammes. The length of the inclined plane traversed by the car being about 1,250 meters, the trip takes:

$$\frac{1,250}{1·5} = 833'' = 14 \text{ minutes.}$$

It now remains to show how the endless cable works. For this purpose we shall follow the car, V, which is coupled to the ascending half, that is to say, to that which is to the left as we ascend the mountain (Fig. 4). When this car, loaded with materials, reaches the top of the inclined plane, it passes with the cable over the vertical channeled pulley, *m*, and is then uncoupled and shoved on to a switch which directs it on to the sole track that leads to the fort and that has a slight incline. The cable during this time has continued its travel, passing first over the pulley, *n*, and then under the guide pulley, *o*, and taking a nearly horizontal position in passing over the pulleys, n^1 and m^1, whose axes are in the prolongation of the pulleys, *n* and *m*. The empty car, which is to descend, has meanwhile been pushed over a shunt on to the down track and coupled to the descending part of the cable, which then carries it along. The same maneuver is effected at the lower station at the same time as at the upper.

Let us continue to follow the working of the cable at the lower station, by a reference to Figs. 14 and 15. On reaching this station it changes direction and passes over pulley *p*, and then under pulley, *q*. Thence it passes twice in succession from one of the channels of pulley, F, of the windlass to the corresponding channel of the tautening pulley, F^1, and finally, after passing into a third channel of the pulley, F, is directed to the ascending track by pulleys, q^1 and p^1. It will be remarked that between pulleys, F and F^1, the cable is crossed so as to obtain as large an arc as possible in the winding and consequently a maximum of adherence.

We have previously remarked that the pulley, F^1, served as a tautener. This object is attained by the adoption of the following arrangement:

The axis of this pulley is borne by a carriage, F^2, that rests upon a portion of the horizontal track through the intermedium of four friction rollers. To this carriage is attached the extremity of a chain, *f*, that passes several times from a pulley block, f^1, fixed to the framework to a block, f^2, mounted upon the carriage, F^2. This chain is kept taut by a counterpoise, Q, whose weight has been regulated experimentally so as to give the desired adherence of the cable on the pulley of the windlass. Such weight is about 500 kilogrammes, and, as the chain, *f*, takes four turns around the sheaves, the total traction of the carriage is 2,000 kilogrammes. The mobility of the carriage upon the small track permits of taking up the slack of the cable.

In Fig. 19 we show how one of the axes which carry the rollers is mounted upon the frame of the carriage, F^2.

Figs. 20 and 21 show the mounting of the axis of the pulley, F^1, upon this same carriage.

Finally, Figs. 22 and 24 give sections of the different pulleys. It will be remarked that, in order to increase the adherence of the cable, the bottom of each channel is provided with a leather band set into a cavity formed for this purpose in the rim.—*Publication Industrielle.*

PERPETUAL MOTION.*

MR. ANTIDE JANVIER formerly published in his remarkable *Manuel Chronometrique* some very correct precepts regarding perpetual motion, and we shall take these as the basis of this note, which is written especially for those of our young readers who still occasionally address to us projects upon this subject. We cannot too often repeat that it is for want of instruction that some very sensible minds believe in the chimera that we are here combating.

We understand by perpetual motion a motion that is preserved and continuously renewed of itself without the aid of any external cause, or an uninterrupted communication of the same degree of motion which passes from one portion of matter to the another, either in a circle, or in a curve reentering itself so that the motion returns to the first motor without having been changed (*Encyclopedie*, s. v. "Perpetuel").

Among all the properties of matter and motion we know of none which can be the principle of such an effect.

It is agreed that action and reaction must be equal, and that a body that communicates motion to another one must lose what it communicates thereto. Now, in the present state of things, the resistance of the air and friction must

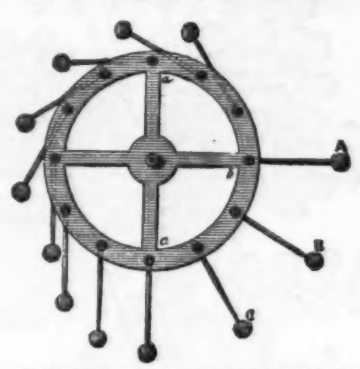


FIG. 1.—JEREMIE MITZ'S PERPETUAL MOTION.

incessantly retard motion. So, in order that any motion whatever should last for ever, it would be necessary that it should be kept up continuously by some external cause, and that would then no longer be what we understand by perpetual motion, or that all resistance should be destroyed, that being a physical impossibility. By another law of nature, the changes that occur in the motion of bodies are always proportional to the motive force by which they are impelled, and are in the same direction as the said force. A machine cannot, therefore, receive a greater amount of motion than that which resides in the motive force with which it is driven. Now, upon the earth that we inhabit all motions are effected in a resistant fluid, and must consequently be retarded. Then the medium must absorb a considerable share of the motion.

Friction must gradually diminish the force communicated to the machine, so that perpetual motion could not occur unless the communicated force were much greater than the generating, and compensated for the diminution that all the others produced therein. But, as nothing gives what it does not possess, the generating force cannot give the machine a greater amount of motion than that which it has itself. So the whole question of perpetual motion in this case is reduced to the finding of a weight that is heavier than itself, or of an elastic force that is greater than itself—a proposition which is absurd. What deceives persons who are but slightly versed in mechanics is that, by means of a lever,

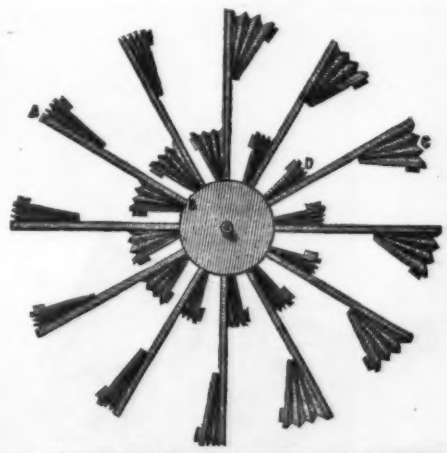


FIG. 2.—BERNARD LAMY'S PERPETUAL MOTION.

any force whatever can always overcome one that is greater. But these persons do not pay attention to the fact that in this very case the expenditure on the side of the least force is superior to the effect that it produces; and that if, for example, a one pound weight lifts a two pound one one inch, it necessarily descends more than two inches.

A power of ten pounds, then, being moved, or tending to move itself with ten times more velocity than a power of 100 pounds, is capable of balancing this latter power, and as much can be said of all products equal to one hundred pounds. Finally, the product on one side and the other must always be 10^0, no matter how we manage it. If we diminish the mass, we must increase the velocity in the same ratio.

Those who are seeking for a perpetual motion exclude from the forces that must produce it not only the air and water, but also all those other natural agents that might be employed therein. So they do not regard as a perpetual motion that which might be produced by the vicissitudes of the atmosphere or by those of heat and cold; but they confine themselves to two agents—*vis inertiæ* and gravity—and reduce the question to finding out whether the velocity of motion can be prolonged, either by the first of these means (that is to say, by transmitting motion by shocks of one body against another), or by the second, in causing bodies to ascend through the descent of other bodies, which afterward mount again themselves while the others descend. In this second case it has been demonstrated that the sum of the bodies, each multiplied by the height from which it can descend, is equal to the sum of these same bodies each multiplied by the height to which it will be able to rise. It would be necessary, then, in order to succeed in obtaining a perpetual motion by these means, that the bodies that rise and fall should preserve absolutely all the motion that gravity could give them, and lose nothing through friction or the resistance of the air, which is an impossibility. If we desire to employ the force of inertia we shall remark that motion is lost in the shock of hard bodies, and that if the bodies are elastic, the live force, in truth, is preserved. But, aside from the fact that there are no perfectly elastic bodies, friction and the resistance of the air must here be left out of the question again. Hence we conclude that we cannot hope to obtain perpetual motion through the force of inertia any more than we can through gravity, and that such motion is therefore impossible.

It is likewise demonstrated that those are greatly deceived who think it possible to obtain a purely mechanical perpetual motion in the same wheel by employing several principles of central forces, such as gravity and the attractions of magnets and of electrical bodies; for, as each of these forces acts equally at equal distances from its center, and can give the wheel arrangement only a resultant force directed by its aid, the system must necessarily remain immovable.

The Académie des Sciences, in 1775, formed the resolution not to examine any more machines that were announced as perpetual motions, and thought it its duty to explain in its history of this same year the motives that had determined it to take this course.

"The construction of a perpetual motion," says the historian, "is absolutely impossible, even though friction and the resistance of the air should not in the long run destroy the motive force. This latter can produce only an effect equal to its cause. If, then, we wish that the effect of a finite force shall last forever, it is necessary that such effect shall be infinitely small within a finite time. Leaving friction and the resistance of the air out of the question, a body to which motion has once been communicated will always preserve it, but in not acting upon other bodies; and the only perpetual motion possible, according to this hypothesis (which, however, cannot occur in nature), would be absolutely useless for the object that constructors of such apparatus propose them. This sort of research has the inconvenience of being expensive. It has ruined more than one family, and in many cases mechanics who might have rendered great services have consumed their fortune, their time, and their genius at it. All obstinate attachment to an opinion that has been demonstrated false, if there is joined therewith perpetual occupation at the same object and a violent impatience of contradiction, is, without doubt, genuine madness."

We shall, nevertheless, make known two attempts at perpetual motion, because they are capable of giving an idea of the delusion that some persons have become afflicted with on this subject.

Fig. 1 represents a wheel that is furnished at equal distances around its circumference with levers, each of which carries a weight at its extremity, and is movable upon a polished pin, so that in one direction it can lie upon the circumference, while at the opposite side, being carried along by its weight, it may be forced to take the direction of a prolonged radius. This granted, it will be seen that when the wheel revolves in the direction *a*, *b*, *c*, the weights, A, B, C, will deviate from the center, and, acting with more force, will carry along the wheel on this side. And since, in measure as it revolves, a new lever will turn up, it follows, it was said, that the wheel will continue to revolve unceasingly in the same direction. But, despite the seducing appearance of such reasoning, experience has shown that the machine will not run. And we can, in fact, demonstrate that there is one position in which the center of gravity of all these weights is in the vertical with the point of suspension, and so the wheel must stop.

The same is the case with the apparatus shown in Fig. 2, which also seems as if it might run continuously. Let there be a wheel, each of whose radii, A B, contains a small channel through which there is a communication between the two bellows, C D, one of which, C, is at the extremity of the radius, and the other, D, is nearer the center. The external side of these bellows is loaded with a weight. This granted, it will be seen that on one side (C, for example) the bellows farthest from the center must open, and those nearest must close. A liquid having been poured into each radius in sufficient quantity to fill its channel and one of the bellows, it is evident that on the side, C, such liquor will be at the extremity, that is to say, in the bellows that are open, while on the other side it will be in the bellows that are near the center. Consequently one-half the wheel will be heavier than the other, and so the wheel itself ought to have a perpetual motion.

It would be quite difficult to show wherein this reasoning is at fault; but whoever knows the true principles of mechanics will not hesitate to wager one hundred to one that such a machine, having been made, will not run.

* From *La Nature.*

AN IMPROVED PYROMETER.

THE apparatus recently introduced by MM. Boulier—described by M. Ch. Lauth, in last month's *Bulletin de la Société Chimique de Paris*—is based upon a very simple principle. It depends upon the thermometric observation of the temperature assumed by a rapid current of water circulating in the furnace under observation. The pyrometer is composed of three distinct parts—the explorer, the reservoir, and the interrupter. The explorer is the most interesting part of the apparatus. It is a small cylinder, formed of very thin copper, a few centimeters in length. One of its extremities is closed; and the other ends in two tubes, one of which is connected with a reservoir of water, while the other is in contact with a thermometer. These two tubes are inclosed in a metal cylinder, which serves as a refrigerator, and is fed by the reservoir of water. This cylinder is one meter in length, and three centimeters in diameter. The reservoir needs no special description. It is fitted with a ball-cock in order to maintain the water at a constant level. The interrupter is composed of a small balance, which is in equilibrium as long as the current of water acts regularly; but on the least interruption in the circulation of the water, it sets in action an electric alarm, and by means of an electro-magnet even cuts off the supply of water. In order to make use of the pyrometer, the explorer is placed in connection with the reservoir of water,

by means of a flexible tube; and after having ascertained that the circulation is regular, the explorer is placed in the furnace, the temperature of which has to be observed. It is fixed firmly in the door, or some other part of the furnace, and a few moments afterward the observations are begun. The water coming from the reservoir circulates in the apparatus and is heated by contact with the flames or the hot air which it meets; showing by the thermometer the changes of temperature which it undergoes.

HIGHFIELD, MOTTINGHAM PARK, KENT.

OUR illustration represents a house for Mr. Joseph S. Moye, the architect to the estate, which extends from Camden Park, Chislehurst, to within a few minutes' walk of the Eltham station. The house is situated near the station, and commands some very picturesque views of the surrounding country. The materials being used are red bricks, relieved by Brown's ornamental and moulded brickwork, Broseley ornamental and plain tiles, and J. K. Cooper's terra-cotta ridges and finials. The builder is Mr. John Grover, of Wilton Works, Islington, N.—*The Architect.*

PHYTOCHROMOTYPY.

SUCH is the name given by the inventor, Mr. Cyme, of Marseilles, to some new processes that have a charming object in view, and that is the production of faithful portraits of plants. An endeavor has for a long time been made to take direct impressions of plants, but the results hitherto obtained have often been imperfect and the processes employed quite complicated. *Phytochromotypy*, the principle of which is based upon the strong tinctorial power of aniline colors, permits any one who is in any way skillful to obtain simply and quickly, upon any surface whatever, impressions of plants in various colors.

Succinctly stated, the principal processes are as follows:

The plant to be reproduced having been flattened and dried between unsized paper, and with a proper amount of pressure, or, for the sake of rapidity, by means of a hot iron, the surface to be copied is brushed over by means of a pencil with an aniline color dissolved in alcohol or in wood spirit, which is cheaper. If the print is to be taken on paper, the latter is allowed to soak in water for a few instants, and is then taken out and placed between blotting paper in order to remove the excess of moisture. After this it is laid upon a sheet of zinc or tin, the plant is placed upon it with its colored and very dry surface downward, and a sheet of fine, strong paper being laid over it and held firmly with the left hand to prevent slipping, every part is lightly dabbed with a wad of cotton.

If the plant is so large that it cannot be held with the left hand, there may be employed with advantage a board having a piece of fine linen attached to one of its edges and capable of being stretched over it by means of a stirrup maneuvered with the foot. By holding the paper and plant in this way, they will be rendered completely immovable.

For the wad of cotton there may be substituted a cold smoothing iron, which should be passed backward and forward lightly over the plant; and then, according as a few sheets of tissue paper are interposed or not between the paper and plant, there will be obtained either an impression of the entire surface of the latter or only its outlines and its network of veins.

It is possible, especially with colors that yield much, such as methylaniline violet, to take several impressions in succession without having to charge the plant with color again. It is necessary, even, to moderate such an excess in coloration if it be desired to avoid blots in the first proofs; and, to effect this, it is only necessary to pass over the surface of the colored and very dry plant a pencil wet with a solution of saltpeter or bay salt, and let it dry well before beginning the printing.

It will be seen that by charging the different parts of the plant with different colors, according to its natural tints, or according to one's taste, diversely colored prints may be obtained. Aniline colors exhibit very varied and bright tints, and all these are capable of being employed which are soluble in both alcohol and water.

With some pains, and after a few trials, prints of remarkable delicacy and clearness may be obtained. If, however, the prints show a few defects, the latter may be corrected with a pencil or pen, as the case may be, dipped into the proper aniline color, dissolved in saltpeter water. Blotted parts must be hidden with zinc white moistened with the same menstruum.

Polychrome prints may be touched up in the same way (particularly if they exhibit too glaring tones) with the proper water colors mixed or unmixed with aniline colors, saltpeter water always being used as the solvent.

FACSIMILE OF A PHYTOCHROMOTYPE.

If the printing paper be moistened with alcohol instead of water, prints of very bright shades will be obtained, and the paper will retain all its luster. By this means prints might be taken in albums, and, in general, upon all surfaces that are injured by water.

Other surfaces, such as gelatine, gummed paper, etc., upon which neither water nor alcohol can be used, are moistened with glycerine.

Finally, if a very light coating of glycerine be spread over a plant charged with color and very dry, and the surplus moisture be absorbed with unsized paper, one or several prints can be taken at once upon dry paper or any other dry surface. The engraving that accompanies this article is an exact reproduction, in black, of a print in methylaniline violet obtained by the last mentioned process. This group, composed of a tansy leaf, a frond of maiden hair fern, and a sprig of grass, shows how perfect is this process of printing. The most delicate plants or parts of plants, and those possessing most detail, give the finest results; and, by grouping these differently, various ornaments may be obtained. With prints of very small plants, pretty and very instructive albums may be formed. Other objects than flowers and leaves, moreover, are capable of being printed by these processes, such as insects, medals, etc. Even those things that seem to be most difficult of reproduction will give prints from sections or proper mouldings.

Prints may also be made upon glass or enamel. In this case it becomes necessary to add copal varnish to the colors dissolved in alcohol, and to employ the plants in a fresh state; the latter, charged with color, being left some time in contact before removing them.

In connection with photochromotypic processes, we may mention the possibility of obtaining enlargements or reductions of the points by the use of Guerin's pantograph. This instrument consists essentially of a sheet of rubber mounted upon a drum and capable of being stretched by means of a screw placed beneath. By covering this rubber with a mixture of glycerine and spirits of turpentine, a print may be obtained of the plant charged with color, and this print, brought to the proper dimensions by maneuvering the screw, will itself afterward furnish a counter impression upon paper moistened with alcohol.—*La Nature.*

SLATE FENCES.

IN the vicinity of slate quarries it is quite surprising to the uninitiated the many uses to which slate is applied; and in no department are these more varied than in forestry—gate posts, fences, both useful and ornamental; tree labels, water troughs, sheds, etc., being made of this material. Of fences three different sorts are usually erected, either solely of slate, or in conjunction with wood or stone. In the following note I purpose to give a short description of each kind, with illustrations, and cost of erection.

For general plantation purposes, Fig. 1 is that usually adopted, the slabs, or pales as they are called here, being of refuse slate, and of the following dimensions: Length 5 feet, breadth varying from 4 to 6 inches, and about 1 inch in thickness; but being made of refuse slate the dimensions may vary a little from those given.

In erecting the fence a trench is cut one foot in depth and eight inches in width along the intended line of fence, care being taken that one side is cut perfectly perpendicular, so as to insure the pales standing in a similar position. These are then placed upright in the trench, with their flat side close to the perpendicular cut, and about three inches apart, and the soil that was formerly taken out is now replaced and rammed firmly. A double fencing wire is then interlaced at three inches from the tops of the pales, and given a double twist between each, thereby insuring the greatest possible stability by uniting the fence and also keeping the pales at equal distances apart. Should, at any time, a pale chance to get broken, it can easily be taken out and replaced without in the least damaging or undoing the fence. When properly erected this is a most useful, and I might almost add, everlasting fence, equaling any, and surpassing most of those now in general use.

A rabbit-proof fence suitable for young plantations can easily be made of the above by placing the pales close to each other; and at any future time, when it may be deemed advisable, every alternate pillar can be removed without in the least damaging the remaining part of the fence.

Including materials and erection, a fence of the above kind will cost 10s. 6d. per rood of eight yards, the pales costing 1?s. per ton, or about 3d. each. These prices may be considered about the average for pales in the immediate vicinity of slate quarries, additional cartage or carriage by rail increasing their value considerably.

HOUSE, MOTTINGHAM PARK, ELTHAM.

Fig. 2 shows a remarkably neat and substantial fence, more usually adopted as a division or farm fence than for ordinary plantation purposes. It is of the following construction, and generally erected where sufficient stones cannot be conveniently procured to form an entire wall. A wall is built three feet high, 24 inches wide at the base, and tapering to 18 inches at the top, into which pillars similar to those already described are built at the distance of 7 feet apart, and projecting two feet above the copestone, which is laid in mortar. Three holes, seven inches apart and three inches from the top, are drilled in each pale previous to building these in the wall, through which wires pass from the straining posts at each end. The straining posts are also of slate, seven

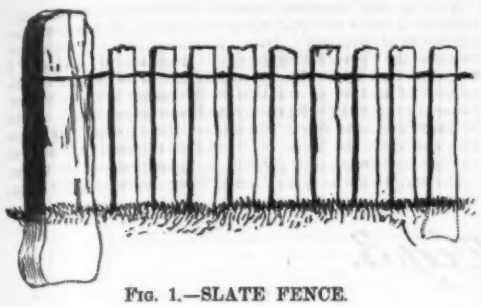


FIG. 1.—SLATE FENCE.

feet in length, six inches in width, and from two to three inches in thickness, and drilled similar to the pales, but with holes of sufficient size to allow half-inch bolts passing through, one end of which is an eye, to which the wires are joined, and the other a nut and screw, by means of which the wires are strained to the required tightness. The erecting of a fence of this kind will cost 7s. 6d. per rood, all materials being placed along the line of fence and convenient for the workmen.

For ornamental purposes, such as garden divisions, or, in fact, any fence used contiguous to dwelling houses, Fig. 3 will be found both neat and serviceable. The cost of this fence, owing to the pales being more carefully dressed and

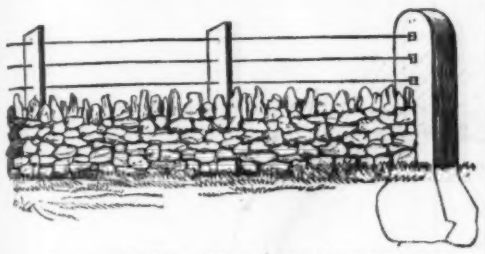


FIG. 2.—FENCE OF SLATE AND WIRE.

rounded on the top, is proportionately higher than those already described. It is constructed in the following manner: A wooden erection is first made by fixing posts in the ground one foot in depth and six feet apart, the posts being four feet in length, either square or triangular in shape, and about three inches square. A rail two and a half inches wide is next nailed to the upright posts at six inches from the top, to which the pales are attached by means of screw nails. The pales are two and a half inches in width, by about four feet in length, six inches of which is sunk in the ground in a manner similar to that described for the first figure, and placed about three inches apart.

When properly erected this fence has a very neat and tidy

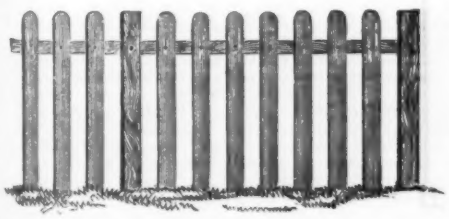


FIG. 3.—SLATE FENCE.

appearance, the wooden supports being hardly visible from the side on which the pales are placed. The cost of material for such a fence varies a good deal, much depending on the size of the pales and the manner in which they are dressed.

There is a very great variety of slate gate-post in use, differing according to the positions in which they are used. They are usually eight feet in length, six feet being squared to nine inches by four inches, and the remaining portion, which is inserted in the ground, being left rough and unsquared. Most of our gate-posts are of slate, and for strength, durability, and neatness they are much in preference to wooden ones.—*A. D. Webster, in The Gardeners' Chronicle.*

RUBBER TIRES FOR VEHICLES.

THE *London Carriage Builders' Gazette* states as follows:

"India-rubber tires have now been in use for several years, and have been found by far the most effectual, if not the only effectual means of preventing noise and vibration in carriages, especially in what are called pleasure carriages. For the use of invalids nothing has been found to equal them, giving, as they do, much of the quiet and comfort of the Cee spring carriage, without the oscillation (which in some cases renders the Cee-spring carriage impracticable), and also without the great additional weight involved in a vehicle hung on Cee and under springs. Their great drawback has, however, been their costliness, and probably they will always remain a luxury. Still, if any means could be devised of reducing their cost, they would doubtless be far more extensively used than at present. Any one acquainted with the systems hitherto in use will admit that the cost is very great, and especially since repairs are practically impossible. In the event of any serious damage nothing remains but to put on new tires. Mr. F. Mulliner's system does, indeed, admit of repairing or replacing the rubber tires more easily, but it is attended with such great disadvantages from its weight and its ungainly appearance as to more than counterbalance this advantage.

"A new system has been brought under our notice, which seems to go a great way toward the solution of the various problems connected with the employment of India-rubber tires, and if not perfect, is much nearer perfection than anything of the kind yet introduced by the trade and the public. The principle of it seems to have been taken from Mr. F. Mulliner's, but it is quite novel in its form. We show in Fig. 1 the form of the iron tire, which is welded together

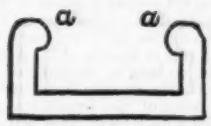


FIG. 1.—SHOWING THE FORM OF THE IRON AS MADE TO RECEIVE THE RUBBER TIRE.

and placed upon the wheel in the same manner as any other iron tire; the sides of the iron tire are turned up and curved in, so as to form a deep, shouldered groove into which the rubber is forced with a tool made specially for the purpose, and it is retained between the shoulders by expansion and atmospheric pressure. The iron tire is bolted or riveted through the felly as other iron tires, but there are no additional bolts or rivets for the rubber tire as in other plans. Fig. 2 shows the same tire with the rubber pressed in, the

FIG. 2.—SHOWING THE RUBBER TIRE PRESSED INTO THE IRON GROOVE.

actual size of the tire before it is pressed into the groove being almost identical with the outer edges of the grooved tire, so that it is practically impossible for it to be displaced. On the other hand, the facility of repairing or retiring is very great, as a new piece of India-rubber, long or short, can be forced in without in any way interfering with the structure of the wheel. This rubber tire, and the tools for compressing it into the grooved iron tire, it is proposed to supply separately, so that the repairing or retiring can be done on the coach maker's premises by his own men.

"These tires are light and strong, easily fitted, repaired or replaced, and at the same time rather increases than otherwise the symmetry of the wheel. They are manufactured by the Noiseless Tire Company, Manchester."

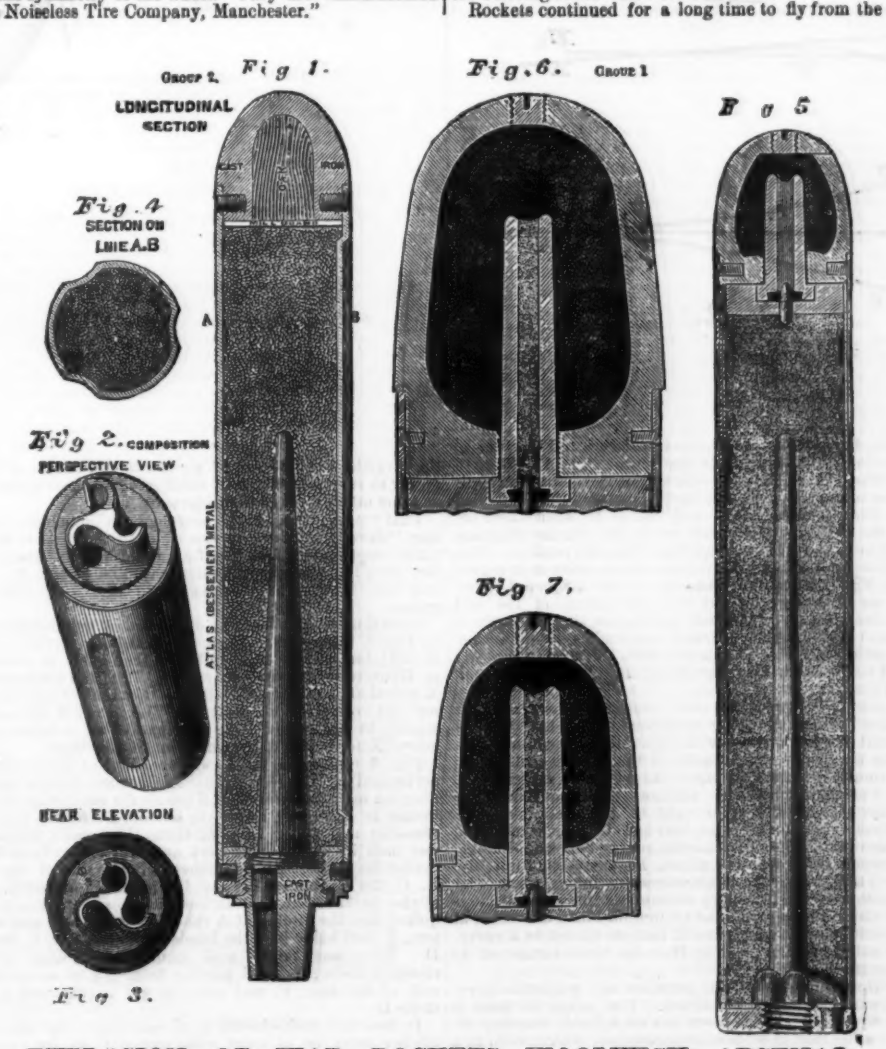
EXPLOSION OF WAR ROCKETS, WOOLWICH ARSENAL.

THE explosion of war rockets in the Royal Arsenal on the 24th of September last was of so peculiar a character as to deserve a special explanation of the action that was going on. Sir William Congreve first got these projectiles introduced into our service on a large scale; they had previously been employed in war by Eastern nations. A war rocket consists of an iron cylinder with a conoidal head—*vide* Fig. 1—filled with composition of the same ingredients as gunpowder—that is, sulphur, saltpeter, and charcoal, but pressed in a column so as to burn rapidly and violently, but not to explode *en masse*. To expose a sufficiently large surface to the flame and obtained the desired violence, a conical hole is made toward the rear end, and a tail-piece is screwed in with vents for the escape of the gas. In former years a stick was screwed into it to keep the rocket head first in flight. Since about 1866 Hale's pattern has altogether superseded the previous kinds of war rockets—see Figs. 1, 2, 3, and 4. These are kept point first by rotation, on the same principle as a rifle shot. The rotation, however, is imparted by means of three shields fixed to the vents, as shown in Fig. 2, which is a perspective view of the end of a Hale rocket. Minor details, such as corrugations in the case and the nature of lining between case and corrugations, need hardly be noticed here, but it should clearly be understood that these rockets are capable of flying straight in any direction without any stick; also, that for some reason, which we doubt if any one could supply, the cast iron head of the rocket has a hollow plugged up with wood—see Fig. 1—instead of having a shell like Congreve's—see Fig. 5—which might be filled, though not kept so in store; so that in all Hale's rockets when the composition burns out there is no further explosive effect. The largest kind made weighs 24 lb. and is nearly 2 ft. long. The general order of processes of manufacture are as follows: The body is made of the Atlas metal—mild Bessemer steel—riveted and brazed along the seam, corrugated and lined with brown paper and calico. The head is made of cast iron and is attached by screws to the body, a millboard disk separating it from the composition. The composition is first pressed into pellets, which are entered into the case and squeezed in succession by hydraulic pressure. Eventually the base and tail-piece are inserted, and the rocket painted, finished, and issued.

The process of inserting the composition has naturally been always regarded as one involving danger, although insignificant accidents only have occurred for a long stretch of years now. When pressure is employed amounting to nearly 100 tons on the head of a 24-pounder rocket, heat and friction may be generated by the slightest irregularity. The buildings, then, where rockets are charged and finished are small detached huts, situated in what may be described as a danger region in the marshes to the east of the Arsenal, while all the means of approach are wooden pathways carrying gun-metal rails for hand trucks. The men are made to wear special clothing and slippers, and all grit is carefully excluded. The buildings are small, and are separated by earth traverses in many cases. They have light roofs of corrugated iron, it being considered that it is better generally for a roof to be blown off easily than to oppose resistance that would generate a violent shock.

The shed where the accident occurred is a small one where rockets are painted and packed, and where, of course, the existence of explosive composition and the presence of iron constitute an element of danger. How the explosion was started is not known, as the only two persons who were in the building at the time were both killed.

Rockets continued for a long time to fly from the build-



EXPLOSION OF WAR ROCKETS, WOOLWICH ARSENAL

ings in all directions. Then men from the various workshops came out of the doors and watched, till occasionally some rockets came whizzing over in their direction, when they would get under cover of the buildings for a minute. The appearance was as if the rockets were being discharged on purpose. Needing no sticks, they flew straight and true in whatever direction they happened to start. Happily, as we have seen, there was no danger of a burst at the end. At the same time, a 24-pounder rocket is a most dangerous and eccentric missile, which differs from a shot in being ready to make a fresh start after any stoppage until its composition is burnt out. Marshal Marmont, who was a great advocate of rockets, argued that a battle was always won, not by the number of men killed, but the number of men frightened. He considered a rocket admirably adapted to effect this end. It may be conceived, then, that hundreds of iron rockets 2 ft. long formed a startling surprise to the neighborhood. We hear that one fell on the top of Shooter's Hill, one on a part of Plumstead Common called the Slade. These distances are about a mile as the crow flies. Many fell in Woolwich and Plumstead, in Green's end, Artillery place, and Hare street; one or two are said to have gone over two miles, none however, causing personal injury. Perhaps as narrow escapes as any are said to have happened in a street close to Woolwich Common, where a woman, who was washing, was startled by a rocket entering the building and cutting away the leg of her table, and a board school girl who had her desk cut through by a rocket.—*The Engineer.*

BASE BALL SCIENCE.

To the Editor of the Scientific American:

Having been for some time in quest of light on this "curved ball" problem, you can imagine that my face brightened at sight of your article on the subject, with the illustrations, in the last number (402) of the SUPPLEMENT, but you will pardon me for saying that I was disappointed upon reading it, and permit me to offer my reasons. You say:

"The curve described by the ball, when thrown without twist, is, of course, in a vertical plane, and in its path it encounters resistance from the air, first to its forward progression; and, second, to its upward movement during the first part of its flight; while, during the second part of its journey, and while falling, the second resistance of the air is, of course, opposite to the attraction of gravity. In either case the resultants of these combined resistances act upon the forward portion of either hemisphere, A B, B C, of the projectile, approaching A or C, Fig. 4, as the direction of motion more nearly approaches the vertical; or, moving toward B as the path of the projectile, traveling in the general direction indicated by the arrow, more nearly flattens. It will be evident, however, that over the entire trajectory there will be a vertical component of air resistance, opposing in one case the rising, in the other the falling, of the ball.

"Now suppose the ball to be thrown with a twist, as indicated by the arrow in Fig. 5. During the first part of its journey, the ball is rising or moving in direction A B. But the resistance encountered by the side A' is equal to

Fig. 1.

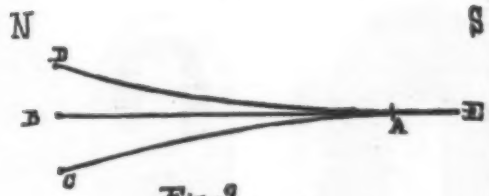


Fig. 2.

W

the sum of the resistances due to translation and that due to the rotation of the ball, while that on the side A" is due to their difference. Hence the ball will be thrown to the right or in the direction A C, and its path, after being impelled in the directions A B, A C, will clearly be somewhere between the two, or, for instance, on A D. (In the diagrams the ball is supposed to be traveling from the reader.) This continues so long as the ball rises, but as soon as it begins to fall, Fig. 6, then the resistance of the air being, from down, up along the vertical A G, the side A" of the ball meets the greatest opposition, and hence the projectile is thrown in the direction A E, and hence takes some intermediate path, as A F; consequently the ball during the first part of its flight drifts to the right, and during the second part to the left."

By your own statement, the "vertical component of air resistance" is null upon the direction of the ball thrown "without a twist." But "with the twist" comes the curve, showing that the essential factor in the change of direction is the rotation of the ball upon its own axis, curving the ball to the right when the rotation is from left to right, *from* the pitcher, and from right to left when the rotation is from right to left—the ball in both cases rotating on its vertical axis. But for this rotation the ball would move, with respect to a vertical plane, in a straight line, the pitcher's arm being the "instantaneous force," while the axial rotation—the spinning motion—is the "continuous force" which changes the line of motion into a curve, or, at least, without which the line of motion cannot be a curve.

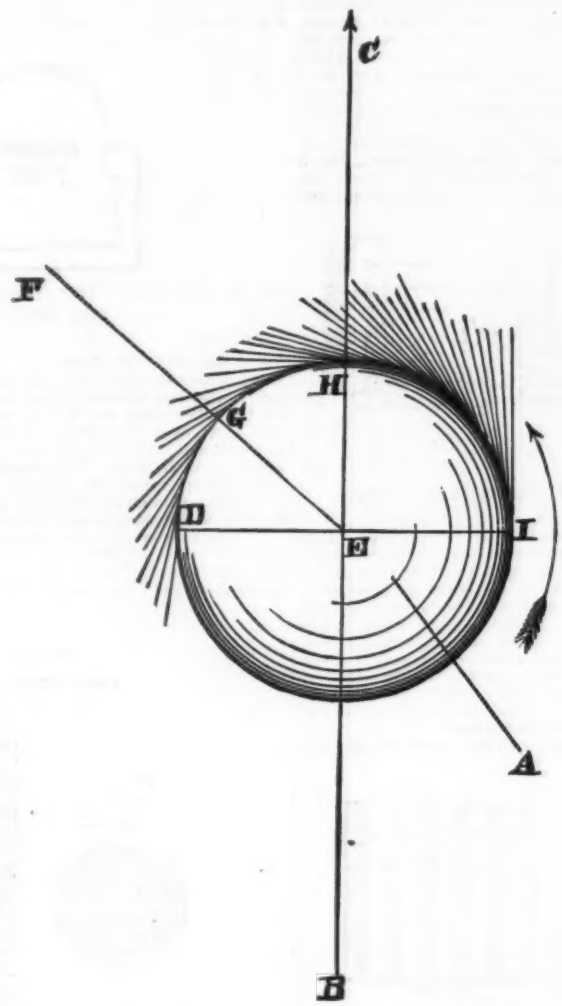
The only question now is, How do these forces *act* to produce the curve?

The three elements of the problem are projectile force, rotary motion, and air resistance. The projectile force is a *vis a tergo;* the air-resistance is a *vis a fronte*, reacting directly in the line of motion of translation, which, even in a trajectory, must be conceived as a succession of infinitesimally short straight lines.

If this view be correct, may we not reject, as an entirely gratuitous complication of the question, the "vertical component of air resistance," and look to the other elements alone for a solution of the problem?

Omitting, as practically null, the slight difference in atmospheric density between the highest and lowest points of the trajectory, the ball encounters the same kind and quantity of resistance—and in the same direction—that is, *directly in front* as to line of motion—in the first as in the last half of the trajectory, allowing only for difference in velocity; how then can any "vertical component of air resistance" co operate with any other element to affect the direction of the ball? If the assumed vertical resistance from below upward have power to change the course of a ball, in the last half of its trajectory, from "right to left," when rotating from *left to right* it ought to have the power to make a ball, discharged on a dead level, curve from right to left, in approaching the earth, in spite of a "twist" from left to right. But this it cannot do. A ball with a right-to-left twist curves, so long as its plane of rotation remains the same, to the left of a straight line extended in the direction and from the point of the primal impulse. And so, in a contrary direction with a twist from left to right. And a curve, first from left to right, and then from right to left, as stated by you, would seem impossible without assuming

Fig. 3.



the "vertical component of air resistance" endowed with a power to reverse the line of rotation of the ball at the apex or some other point of the trajectory.

That "projectiles," in the language of Commander Cooke, may "deviate in a curved line *either* to the right *or* left" is quite conceivable; but this fact furnishes no ground for the assertion that a projectile may first curve to right and then to left, as represented in Fig. 7 of your diagrams.

Referring to the inclosed diagrams: A ball discharged at A, Fig. 2, in the line E B, *aimed* at B, may deviate toward D or C, but not first toward D and then curve in toward C or B; or, referring to your own Fig 7, a ball discharged at X aimed at Z may curve either to the right or left of Z, but not first toward T and then to Z. The line X M Z should be wholly to the left of X Z, terminating at a point distant left of Z according to the measure of the curve.

Fig. 1 represents the local conditions of the experiment performed by Mr. Robert Black, a pitcher for the Quincy nine, on my own grounds. E stands for the first stake, two inches in diameter; F for the second, a tree five inches in diameter and 49 feet from E; D the third stake, a rakestale one inch in diameter, 18 feet and four inches from F. A marks the position of the pitcher, out of reach of the stake E. C, the catcher. DEF in line north and south, with pitcher and catcher west in line of the extreme stakes. Required that the pitcher at A shall throw his ball east of the tree, F, and lodge it in the hands of the catcher, C, west of D. This was fairly and unmistakably done on the eleventh throw, the ball passing from six to seven inches east of the tree, F, and quite as far to the west of the stake D.

In this case, undoubtedly in all such cases, the *aim* of the pitcher must be at some point east of F, as, for example, in the line of B; AB being the line of primal impulse, a straight line, to the right, or east, of which the ball does not pass, but curves always, with the left twist, to the left of AB, with a rapidly increasing curve toward C.

Permit me to point directly to what seems to be the essential error in your theory.

Referring to Figs. 5 and 6, you say:

"This continues (that is, the curve to the right) so long as the ball rises; but as soon as it begins to fall (Fig. 6), then, the resistance of the air being from down up along the vertical AG, the side A' of the ball meets the greatest opposition, and hence the projectile is thrown in the direction AE, and hence takes some intermediate path, as AF; consequently, the ball during the first part of its flight drifts to the right, and during the second part to the left."

Now as this assumed upward resistance is, as you say, vertical, it must be equal upon every point of the lower hemisphere of the ball. How, then, can such a resistance transfer the "greatest opposition" from the side A' to A"? The direction of motion of translation is the same; the direction of motion of rotation is the same; there is no new element except the alleged upward resistance, which can be no more upon the side A' than upon the opposite side. How this can shift the locus of "greatest opposition," and so change the direction of the ball, is incomprehensible to me.

Presumptuous as it may seem, I beg leave to offer an explanation, the key to which is derived from a suggestion of Mr. R. J. Houston, one of the parties to the Lancaster, Pa., experiment, and which I take from a letter addressed to him on the 11th inst.

In justice to Mr. Houston I give his thought in his own words. Speaking of the curve from right to left, he says:

"The right side of the ball moves forward in this spin and the left side backward, just the reverse of the movement of the ordinary top in spinning. It follows from this movement that the right forward portion of the ball will have not only the friction or resistance of the air from its forward motion, but in addition the friction resulting from the forward movement of its surface in the spin which it is making; while the left front portion will have less than its half of the friction or resistance, because its surface moves back from the resisting air in the spinning movement.

"The friction of the air incident to the spinning motion being added to the resistance on the right side of the ball and deducted from that on the left side, it follows from well known law that all moving bodies tend toward the point of least resistance, and that the ball is gradually pushed over to the left."

To this I said that he had doubtless hit upon the true explanation, though it involved one difficulty. Since the greatest curve must be at the point of greatest resistance, and the greatest resistance at the point of greatest velocity, which is always at the source of projection, the greatest curve would be nearer to the pitcher than the batter, and render it, in the apt phrase of Mr. Whitmore, the secretary of the Quincy Base Ball Association, "non-effective" in foiling the aim of the batter; but this is in accordance with neither the claim nor the fact. In the trial here the curve was "sharp, quick, and decisive" within the 18 feet between the tree and the catcher, while the pitcher was nearly 50 feet from the tree, or middle stake.

May not this be because the spinning motion, having only

surface friction to overcome, persists longer, relatively, than the forward motion, and so takes effect more decidedly when the ball, as a projectile, is "slowing up"?

In the diagram which I send you with this, Fig. 3, A is the ball moving in the line of BC. The molecules of air cling to the surface of the ball under a pressure of about 15 pounds to the square inch. When this pressure is overcome by the spinning motion of the ball, they are thrown off tangentially, all those lying on the quarter of the sphere, IEH, directly in front of the ball, compacting the air, and by so much impeding its progress; all the molecules in contact with the next left quarter of the sphere, HDE, are thrown partially *away* from the ball—excavated, so to speak—thinning out the air by reason of its inertia and elasticity, thus opening an easier way for the ball in the line, EF, than in the line, HC. The point of least resistance being near D, and the point of most resistance near H, a glancing surface is formed near to H, by which the ball is "pushed" more or less toward the line EF.

Yours respectfully,
R. C. RUTHERFORD.

Quincy, Ill., Sept. 19, 1888.

PHYSICS WITHOUT APPARATUS.

WE recently published some experiments relative to the equilibrium of bodies and to center of gravity—a subject which is almost inexhaustible, and one which may be easily demonstrated in a thousand ways. Fig. 1 shows still

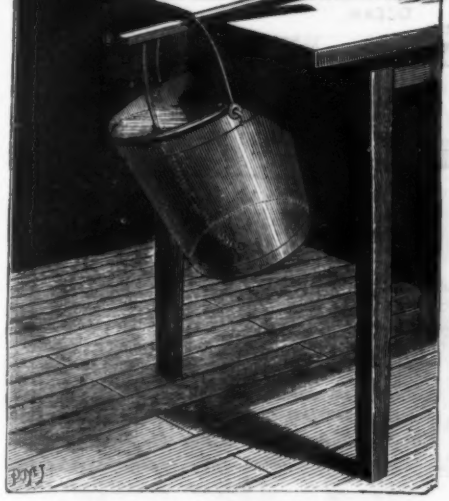


FIG. 1.--EXPERIMENT ON CENTER OF GRAVITY.

another old experiment on the center of gravity. It consists in supporting a pail filled with water, by means of a stick, AB, simply placed on the edge of a table and passed through the bail. To be successful with this experiment, which appears like an impossibility, it is only necessary to place a small rod, CD, of suitable length, between the p int, B, of the suspension stick. AB, and the bottom of the pail. The system thus consolidated forms, after a manner, a single mass; and the pail is readily held in the position shown in the cut, because the whole center of gravity of the system is beneath the point of suspension situated nearly at the center of the stick, AB.

On another hand, one of our readers communicates to us a very curious experiment on equilibrium, that he has often seen performed, in former times, by French soldiers in Algeria, when they were on swampy land and had nothing to sit upon. On such occasions they seated themselves upon each other's knees, as shown in Fig. 2, and, when they were in sufficient number, they placed themselves in a circle so that the soldier who terminated the file sat upon the knees of him who was at the beginning of it. They thus formed a circular chain without a break. We recommend our collegians to try this method of resting when they come together after their vacation.—*La Nature.*

MAGIC RINGS.

AN OPTICAL ILLUSION.

THE rings reproduced in the annexed cut from a photograph of the objects double actual size, are formed of metal twists, the strands of which are alternately golden yellow and silver white. The rings have the same diameter at all points, and the metal strands of which they are composed have everywhere the same thickness and are parallel with each other. Now, when we regard one of these rings edgewise, it gives rise to the following illusion: the twists of metal seem to approach one another toward the bottom, and the ring appears to be much narrower at that part than at the top. When the ring is revolved around one's finger, the apparent narrowing is always produced at the same point. The ring figured to the left of the cut gives a good idea of the illusion, but, with the real object, such illusion becomes much more striking. In the ring with three twists, the middle one appears to be very perceptibly inclined, but the engraving has caused the disappearance of the illusion which exists on the real object. The purpose of the ring to the right of the cut is to show the arrangement of the twists.

The illusion that we call attention to is a curious one, and enters into the class of those that we have described under the title of Illusions in Ocular Estimation, and where we have cited the example of parallel lines which appear to be convergent or divergent when oblique and close lines are traced on them. In the case of the magic rings the phenomenon is assuredly completed by the reflection of the light on the rounded strands of the metal twists. The brilliant point of reflected light occurs on the external edges of the ring at its upper part, and toward its middle at its lower part. The ring figured to the left gives a pretty accurate idea of this fact.

It is probable that other objects might facilitate the study of this sort of illusion. Twists of silk of different colors,

MAGIC RINGS.

wound around a hoop or ring, would perhaps reproduce the phenomenon. We shall leave the trying of the experiment to those of our readers who are interested in such questions.—*La Nature.*

[BUILDING NEWS.]

THE EARLIEST MAP OF LONDON.

THERE came to Winchester, in the year 1521, Ferdinand Columbus, nephew of the great circumnavigator, who was then in the suite of Charles V. when he visited England. Ferdinand's travels in Europe extended over the period 1518–1525. An enthusiastic collector, he made a catalogue of all the books, maps, and plans which he purchased. The catalogue (in his own hand) is preserved in the Cathedral Library at Seville. One item runs as follows: "Bought a map of London, engraved on copper, dated 1497." This entry is of twofold interest, as relating to the first known map of London viewed as a whole, and to an early mention of engraving on copper, an art that had been introduced in Germany but a few years before. Ferdinand's map has still to be found. The next in date known to the present age is that in the Bodleian Library, of date *circa* 1550, and which has just been reproduced in facsimile by the Typographic Etching Company for the Typographical Society of London; the second series of sheets now being finished. The original is due to the hand of Antony Van den Wyngaerde, a Dutchman, of whom little can be said more than that he is believed to have been attached to the suite of Philip II., of Spain, when he came to this country as the bridegroom of Queen Mary. His work speaks for itself. It consists of a free-hand drawing, about 10 feet in length and 20 inches high, comprising a view that extends from Lambeth and Westminster to Placentia, the palace at Greenwich. The course of the river is clearly marked; the few buildings in Southwark appear necessarily in a widened perspective, while in the middle distance the cities of London and Westminster, boldly sketched, stand prominently forward. Many of the buildings and localities are indicated by name, the writing in most cases being hard to decipher. Not the least merit of the Dutchman's drawing lies in the fact that its faithfulness is manifest when compared with those which succeeded it. In 1560 Ralph Aggas' pictorial map was published, followed by those of Finder (1561), Mosden (1600), Visscher (1620), Hollar (1647), and so on. These corroborate one another in every important feature of detail, and are of singular interest, as delineating the city spires and churches as they stood anterior to the great fire.

Looking at the map, the eye instinctively rests upon its central feature, the old cathedral church of St. Paul, with its fine length of nave and choir, extending to nearly 700 feet, its central tower and spire 520 feet high. This is the building as yet undisfigured by Inigo Jones' incongruous portico, albeit robbed of its spire by lightning a few years after the drawing was made, that Denham sings, in "Cooper's Hill," celebrating its majestic beauty in the stanzas beginning:

That sacred pile, so vast, so high.

He goes on to say—

Now shalt thou stand, though sword, or time, or fire,
Or zeal, more fierce than they, thy fall conspire.

But he lived to see the ruin of his theme begun by the one and completed by the other, while singularly enough, we find him shortly before his death engaged as the King's Surveyor General, at the erection of the new cathedral, successor to that "aspiring mountain or descending cloud," for which he had presaged immortality. More immediately in the foreground is St. Magnus' Church (rebuilt by Wren) and the high leaden steeple of St. Dunstan's in the East—the latter now replaced by Wren's beloved spire, the design of which is attributed to his daughter. Nearer still appear London Bridge, the original work of Peter Monk, of St. Mary Colechurch, in Coney-hoop lane, Old Jewry, with its central chapel of St. Thomas à Becket, and the gate at the southern end, hideous with the heads of traitors. Below this appear Winchester House, the inn of the bishops of that see, St. Mary Overy's, and Suffolk House, the sumptuous foundation of Charles Brandon, Duke of Suffolk, in the reign of King Henry VIII. Falling into that sovereign's hands, this house was renamed Southwark Place, and the modern Mint street marks the site of the "mint of coinage there kept for the king." Bankside is without the theaters and bear gardens which are so conspicuous in later views; and on the spectator's left appear the chapel, with the then newly erected gate-house of Archbishop Morton, at Lambeth Palace. The ancient Palace of Westminster, and the Abbey, innocent of Wren's western towers, stand out on the left bank of the river. By the Hall is St. Stephen's chapel, and in front the clock tower, so long the distinguishing feature of New Palace Yard, originally built *temp.* Edward I., out of the fine imposed on Ralph de Hingham, Chief Justice of England. To the north is the Leper Hospital, indicated by its new name of St. James's Palace, and beyond are seen the manors of Neyte and Hyde, which, long the property of the collegiate church of Westminster, were, together with the advowson of Chelsea, exchanged to King Henry VIII. for Hurley Priory in Berkshire. Hyde Manor had been fenced in with inclosures for deer from a remote period. Here, at the date of this map, the French ambassador would hunt with the king, and here, in 1578, the Duke Casimir "killed a barren doe with his piece from amongst 300 other deer." Hyde Park was first walled in with brick in the reign of Charles II., the wall being replaced with an iron railing about sixty years ago. King Henry VIII., annexing St. James's Manor and surrounding it with a wall, connected the park thus formed with Whitehall. The Whitehall drawn by Wyngaerde is the palace which King Henry VIII. built for himself on the site of York House, delivered to him by a charter of the 7th of February, 1529, on the downfall of the Cardinal, who had lived there in more than regal splendor. Nothing remains of the buildings shown but a portion of wall in Whitehall yard, and the Almonry and Queen's Treasury, at last doomed to a speedy demolition in one corner of the now desolate garden of Fife House. Between the old Palace of the Scottish Kings and the Eleanor Cross at Charing, plainly indicated, is to be distinguished the most westerly of the series of town mansions which ranged along the river from Blackfriars to Whitehall. The building here seen is the original of Northampton House, so named after Henry Howard, Earl of Northampton, son of the Earl of Surrey, the poet. The Earl of Northampton left his house, as reconstructed in 1605 by Bernard Jansen and Gerard Christmas, to his nephew, Thomas Howard, Earl of Suffolk, when it received the name of Suffolk House. Thus it was called until the marriage of the Lady Elizabeth Howard, daughter of Theophilus, second Earl of Suffolk, with Algernon Percy, tenth Earl of Northumberland, who; from taking an active part in the civil wars against the king, strenuously promoted the Reformation. Sir Hugh Smithson, Bart., the husband of their lineal descendant, the Lady Elizabeth Seymour, grand-daughter of the "proud Duke of Somerset," was created Duke of Northumberland in 1766. The recent destruction of Northumberland House, which, however, comprised very little that was old, and the erection of monstrous hotels upon its site is an act of vandalism ever to be regretted by all who have any regard for the picturesque enhanced by associations with the past. Burghley House and Bedford House on the north side of the Strand are absent from Wyngaerde's map, for they were not built until the succeeding reign; but at the time of the Reformation the riverside was lined with the "inns," or hostels, appertaining to no less than nine different sees. These with the "houses" into which the bishops' residences were converted, are still commemorated in the streets that run down to the river. Essex street derives its name from Essex House, which had been the Bishop of Exeter's; Arundel street, from Arundel House, made familiar by the views of Hollar, once the property of the Bishops of Bath. For his new palace the Protector Somerset laid violent hands on the inns of the Bishops of Worcester, Chester, and Llandaff, while that of the Bishops of Carlisle was pre-

FIG. 2.—EXPERIMENT ON EQUILIBRIUM.

sented by the Crown at the Reformation to the founder of the Russell family. Under the Earls of Bedford it was known as Bedford Russell House, and when they removed to their new Bedford House, on the site of the now Southampton street, the inn took the name of its occupant, Edward, second Marquess of Worcester, author of the "Century of Inventions." His son was created Duke of Beaufort, and hence Beaufort buildings. It was in Worcester House, when leased by Lord Clarendon, that his daughter Annie was married at midnight to the Duke of York, according to the rites of the English Church. Durham street and the Adelphi mark the position of the Durham House, as shown in the map—originally built by Thomas Hatfield, who was bishop of that see for thirty-six years. It is notable as having been a residence of Sir Walter Raleigh, of whom Aubrey relates that he well remembers his study there, being "on a little turret, that looked into and over the Thames, and had the prospect which is as pleasing, perhaps, as any in the world." In the collection of Inigo Jones' drawings at Worcester College, Oxford, is the elevation (designed by his pupil Webb) of a large house which the Earl of Pembroke at one time proposed to build here. About our artist's time Somerset House was commenced at a vast expense, after the plans of John of Padua, "deviser of his Majesty's buildings" to King Henry VIII. It is said to be the first mansion of its kind built in this country after the Italian style. Several views of it exist, those by Kuyff and Sloss being the earliest and the best. The picture in Dulwich gallery shows the river front before it was spoiled by Inigo Jones' chapel and other alterations. The mouth of the Fleet River may be discerned between what Stow describes as the "stately and beautiful house" which Henry VIII. built for himself in 1522 near St. Bride's Well, and the monastery whither, in 1276, the Black Friars removed from their first London settlement by Lincoln's Inn, under the auspices of Kilwarby, Archbishop of Canterbury, and Edward I. and Sir Roger de Coverley dwelt with such complacent pride as he was rowed to Spring Gardens from the Temple Stairs. Had Sir Christopher Wren completed his contemplated tour at leisure instead of being recalled from Paris, he would have attained to a greater mastery of the Gothic style; had he accomplished his ulterior purpose of visiting Greece, a second age of Perikles might have dawned for our metropolis, while the Propylæa and the Akropolis visited before their bombardment, with Pheidias and Mensikles, Iktinus and Callikrates for his guides, Wren would have proved himself the greatest architect whom modern times have known.

W. E. MILLIKEN.

HISTORY OF NAVIGATION.

IN our time so many different things are known, and especially spoken of, and so much is seen represented of what is occurring in all countries, that objects pass like a train of cars and cannot be really appreciated. The desire of knowing something new is only the more excited by this, and what is of old date must be presented in a very concise way to succeed in finding a place amid novelties. This is what renders resumés interesting, especially when it concerns things that we know little or nothing of, and that we pass by if a glance is not sufficient. So it will perhaps prove of some interest to reproduce very briefly the history of navigation in past ages, by reproducing in these pages the craft that have successively served man for starting from his own corner of the earth to go facing the unknown and its perils in order to fathom the unknowing things of the sea, and to succeed after all in knowing and enjoying what our planet produces. This presents so much the more historical interest in that the world is tending to become uniform in its costumes, its implements, and especially in its ships. This is a natural consequence of the facility with which most distant parts may be communicated with, this being something that ships have yard. There are no traces of any means for reducing its surface.

After a long lapse of barbarous times, we see the return of the ship with oars. It is always low in the water, in order that the oars may emerge easily, and long, both for better clearing the water and for giving sufficient space to the oars, which the weakness of man's arms forced the multiplication of. Among the ancients this was effected by placing them in superposed banks, the number of which has been exaggerated to an impossible degree. The middle ages employed multiple oars, the men being placed upon the same bank. The galley had also single sweeps which were maneuvered by five or even nine men, and which were called scaloccios. The left side of the engraving (Fig. 1) clearly shows the transformations of the ship actuated by oars, from the limit of our history up to about two hundred years ago. A comparison of this with the right side, which is devoted to the ocean, shows the complete ignorance of maritime history of this part of Europe, since the first example sketched belongs to the Beauvais tapestry, that is to say, to the epoch of William the Conqueror. But all show, in miniature, the feudal castle carried at the extremities of the vessel, and at the top of the masts, for the archers. The oar does not appear, since it is better suited to troubled waters, and the only motor that the ship has is square sails that are often covered with embroideries as profusely as the armor of the knights. For rudder, all these ships have only a large oar at the side, and they show no traces of our modern methods of reducing at will the surface of the sails. We still find among the Malays a part of the types of these ancient ships, which were built rather for military expeditions than for extending their navigation a little further.

There is an entire uncertainty regarding the ships that played so great a part in carrying Saint Louis to Syria, and Gama beyond the Cape of Tempests in order to open up a new route and replace that which was traversed by caravans

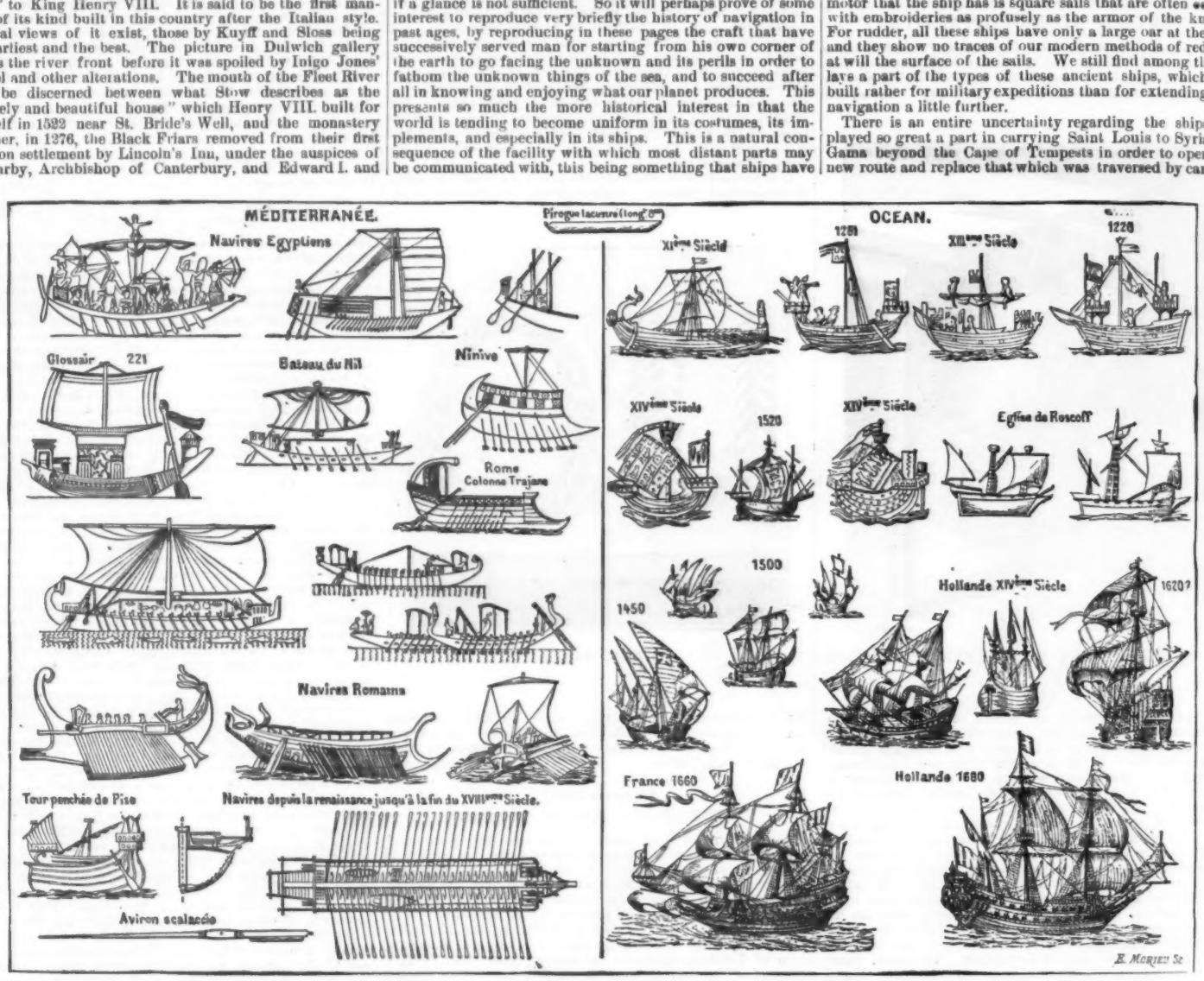


FIG. 1.—BOATS FROM THE LACUSTRINE PIROGUE UP TO SAIL VESSELS OF THE 17TH CENTURY.

his queen. The ruins of the Tower of Montfitchet, which Henry VIII. had pulled down for his new palace of Bridewell, were given to the Black Friars. The last remains of the monastery were destroyed a few weeks since. They consisted of the old wall in Little Bridge street, Ludgate Hill, erroneously deemed to have been part of the later Roman wall around London, being composed in part of the materials of the Roman wall at this spot, which the friars had pulled to pieces for their own purposes.

Reverting to the city, the following churches shown in the view, and which were not rebuilt after the great fire, may be instanced: All-Hallows-the-Less, St. Leonard, in Foster lane. St. Mary Bothaw (Boat Haw, or Boat Yard), Walbrook; St. Mary Mounthaw, or Mounthaunt, Queenhithe; St. Mary Woolchurch Haw, site of the Mansion House, so termed from a beam placed in the churchyard for the weighing of wool; St. Michael le Querne, by the Corn Market, at the western end of Cheapside; St. Nicholas Acons, Lombard street; St. Olave, Silver street; St. Peter, Westcheap, where the big tree yet grows; St. Thomas the Apostle, Soper lane, site of Queen street, Cheapside; All Hallows the Cellars (All-Hallows-the-Less), Upper Thames street; St. Gregory, at the southwest of St. Paul's; and All Hallows, Honey lane, site of the old City of London School. But the list of those which, either having escaped the flames, or having been rebuilt, subsequently fell a prey to an equally fatal destroyer—the Moloch of Improvement—includes upward of twenty-nine churches. Within the past few years many of Wren's edifices—his masterpiece of St. Antholin's in Watling street among them—have been leveled with the ground. As has been well said—*Si monumentum requiris ne circumspiciate.* The Union of Benefices Act, coupled with the Bishop of London's Union of Benefices Commissioners Bill, will, ere another generation or two shall pass away, leave us well nigh deprived of a collection of towers and steeples for which London was unrivaled, and upon which largely contributed to, since they have no longer to fear tempests, and since steam allows passages to be made in days that it took sails weeks to effect.

Now, the Museum of the Navy is at present a resumé of the industry of ages, in that it contains not only what has been produced by the most civilized peoples, but also the limited efforts of savage ones, upon whom the ignorance of the production of metals has imposed the same limits of action and the same materials as it did upon our ancestors of the stone and bronze ages.

This collection, which is more unique in its kind than one of statues or pictures, leads us to remark that the same limits of action and the same materials produce the same results, whatever be the epoch; and, seeing that we ourselves had formerly only canoes hollowed out of a tree, we are forced to believe that, since there are still isolated peoples who are yet at this stage, while others have gradually advanced, it is possible to get up a chronological history of navigation by a geographical stroll through the Museum of the Navy. This collection of models is too extensive to be represented upon a single sheet of paper, and, as we are always interested in what belongs to us, we have thought it wise to confine ourselves for the present to forming a collection which we may call the European marine, grouped upon one sheet.

It starts with a lacustrine canoe recently found in Lake Neuchatel, this being something that all peoples living on agitated seas have been confined to longer than those whose fine climate permitted of daring more, and consequently of improving. So it is among the Egyptians, who have preceded all peoples, that we find traces of ancient ships preserved on the stone of their monuments. We see that the oar was then almost exclusively employed, the sail being only an auxiliary aid. Nineveh shows two banks of oars, as do also the sculptures of Rome and Athens. The rudder is merely an oar held over the side of the vessel, and the sail, always rectangular, is suspended by the center of its and Arabian ships. We are scarcely any more certain as to the nature of Christopher Columbus' ship, the Santa Maria, with which he discovered those new lands that proved a continent, and that too while searching for the lands of Marco Polo. There has been much discussion in regard to these caravals of Columbus, but it is agreed that they must have resembled a pretty picture in the National Library which is reproduced in the figure of the boat of 1450. This sketch shows us the triangular sail that we call "Latin," but which was not used by the ancients, and which appeared among us at the epoch of the Crusades. Perhaps it came to us from the Arabs, who still have one almost like it.

Afterward come those vessels with which the Dutch supplanted the Portuguese in the East, and which they so much improved as to make themselves for a long time masters in construction. To this new science, and to their courage, they owed their resistance, openhanded, upon the sea, to united England and France, when the latter was invading their country. The aspect of the two sides of the engraving shows the difference produced by the seas. On the one side, the more tranquil waters have produced that low and long vessel which for a long time ruled the Mediterranean, with its oars in the hands of the Genoese and Venetians, up to the time of Louis XIV.; and, on the other, that round ship which, large, short, and very high in the water, was soon found to be more suited to the ocean, and which employed sails only, whose maneuver, requiring but little power, permitted of making upon the ocean long voyages that were forbidden galleys through the difficulty of carrying sufficient provisions for their large crew. This division, marked by a line drawn through the center of the plate, lasted until the arrangement of the sails and the art of maneuvering them had been sufficiently perfected to permit of a dependence upon the wind alone; and it may be said that it is to such art of maneuvering that is due our knowledge of the world, since

the latter could never have been traversed by the galley. It was this cause, too, while not permitting of an enlargement of the ship, that made it carry numerous large cannon in order to convert it into a floating citadel that possessed a formidableness that the fore and aft castles of the middle age ships were nearly destitute of. It will be seen how high in the water the ships sat, and also how the imperfections in artillery forced them likewise to interior defense, by aiming small pieces at the assailant whom the large guns could not keep off to a sufficient distance to prevent boarding. So the cannons in the tops aimed into the ship; and, in 1600, it became a question as to what part of the deck could be thrown up or tilted so that the assailants could be thrown down and shot.

All these ships have square sails, which some of them superpose and crowd into the tops, but do not tie to the yard as we have been dexterous enough to do since. Surface is diminished only by removing the cords that connect the lower canvas. The vessels are provided with hinged rudders, the epoch of which it is difficult to fix, and which is an important invention that appears to belong to Europe, as is also the present manner of adapting the sails to the wind by taking reefs in them. These inventions, as well as superposed sails, did not leave the hands of Europeans for a very long time, and, as yet, only very rare imitations of them are seen in the far off countries of the East. They have done much toward allowing the dimensions of the ship to be increased in giving it a more powerful motor, and consequently permitting it to meet tempests better, while at the same time allowing it to traverse greater distances. For the last two hundred years they have permitted of the maneuver of ships with five superposed decks, four of them provided with cannon weighing 4,500,000 kilogrammes, and the vessels spreading 4,500 square meters of canvas, which man has succeeded in all times in mastering with his feeble hands. It has become requisite that the steam engine, which has was already too weak in artillery, and could not be increased to the degree that the galleon had been, so as to carry more. The rower likewise remained weak, and his rowing apparatus took up just so much space. In 1683 a vessel, which was called Le Bon, and which must have resembled La Couronne, was attacked by seven Spanish galleys, to which were added twenty-three others, and would perhaps have succumbed had not a slight breeze arisen. But this was already an evident proof of the transformation that the ship had just undergone, for there were here 12,000 to 14,000 men against 600 to 800. So the role of galleys did nothing but decline in measure as the ship was improved, and their last feat of arms was confined, in 1683, to towing the vessels of Duquesne under the walls of Algiers. Genoa and Venice, having nearly disappeared from maritime scenes, kept these craft, however, under roofs, where they were preserved in a manner that causes it to be regretted that we do not see ships put high and dry instead of limiting their duration to a dozen years without large repairs. It is probable that the last galley was employed on the Black Sea, by the Russians in 1796. A plan of it has been published in the souvenirs of the marine that have been preserved.

On following the order of dates, we see all traces of the galley gradually becoming effaced, the stern lowering and the middle and the prow rising in order to come on a level. The canvas takes a breadth that it has scarcely exceeded, the maneuvers are well directed, and the masts are firmly held by numerous shrouds and stays. The bowsprit alone is not as yet well supported, because of the importance accorded to the sail that it carries beneath it. The Sans Pareil of 1770 would have eclipsed everything in our harbors by the splendor of her ornaments. So, too, we shall remark very little difference in the Wagram of 1800, and in this same sort of vessel, modified in its upper parts, the Montebello of 1835, which terminates the series of beautiful sail vessels for the last two hundred years. Alongside of the unites within itself every quality. It is even going to try to become invulnerable by covering itself with iron. But modern science has prepared a terrible reptile—the torpedo; and the lion will have to fear this little serpent.—*Admiral Paris, in La Nature.*

HEATH'S BOLIVIAN EXPLORATIONS.

By REV. J. D. PARKER.

BOLIVIA unfolds to the traveler the most diversified physical features. Two chains of Cordilleras, running nearly parallel with the coast, carry their lines of snow-clad peaks like sentinels across Bolivia, but are separated by an intervening table-land, from 100 to 200 miles in width, which, when the mountain-chains were folded, was lifted as a connecting plateau more than 12,000 feet above the level of the ocean. On the Pacific slope the descent from the western Cordillera is steep and difficult, terminating in a rainless plain, where no vegetation appears except where mountain torrents margined by narrow valleys force their way to the Pacific Ocean. Beyond the eastern Cordillera stretches eastward for hundreds of miles a vast plain of great fertility, through which with gentle flow thread various affluents to the Amazon. During the rainy season portions of this plain are overflowed, and the vast perennial forests, disclosing glimpses of the watery waste, seem like islands of foliage on some inland sea.

Bolivia, occupied now by two millions of people, and possessing rich mines of precious metals, has sought for centuries to find with Europe a more direct means of communication. Nature has furnished her river outlets connecting with the Amazon, but these have been useless to commerce, because they were unexplored. The products of the vast alluvial plain laying east of the Cordilleras, the largest portion of Bolivia, found a slow and toilsome transit on the backs of mules over two chains of Cordilleras with their barren

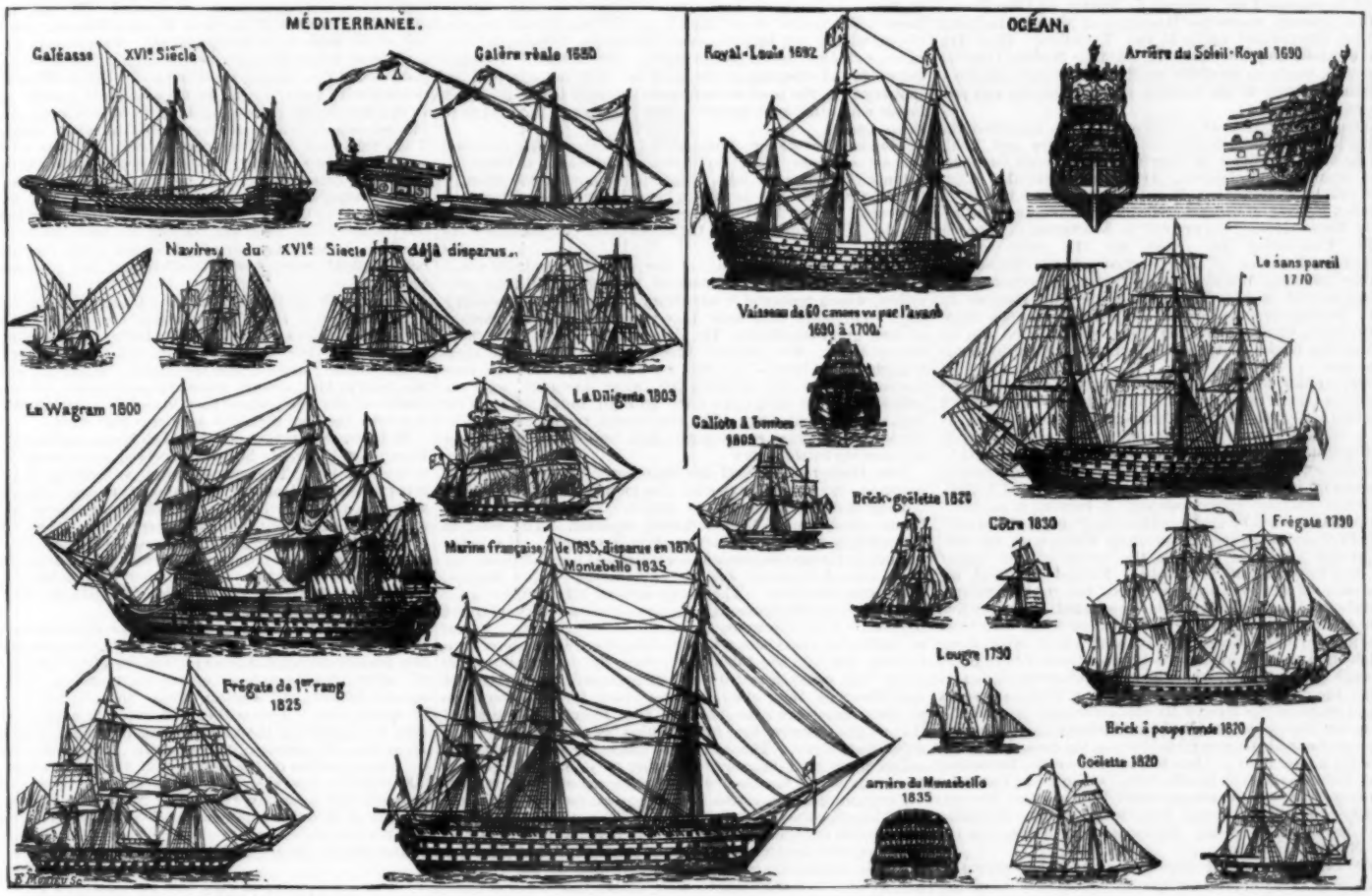


FIG. 2.—SHIPS FROM THE GALLEASS OF THE 16TH CENTURY UP TO SAIL VESSELS OF THE 19TH CENTURY.

rapidly reached an adult age, should produce a power that fable would scarcely have dared give the Titans, in order to propel masses like modern armor plated ships and the Great Eastern.

The second series (Fig. 2) shows maritime improvements of all kinds, such, for instance, as the galley armed with cannon, as well as the galleon, arrived at a stage from which it did not change till its disappearance from maritime scenes, and the Latin sail adapted for the Mediterranean, and which continued in use upon the elegant xebecs up to the beginning of our century, thus presenting the last remains of a special marine effaced by the adoption of those types adapted to all seas that are represented in the last lines of the plate. The vessel of war was improved in France under Louis XIII., and we find a complete historic account of it in the work of a Jesuit, original and learned for its age. This book contains a plate which is reproduced in the figure marked "France, 1660," and which represents La Courenne, a vessel that was commanded by Messrs. D'Harcourt, De Brégé, and Mgr. De Sourdis, the Archbishop of Bordeaux, who commanded one of the squadrons of the King. A geometrical drawing of this will be published that will permit of a model being made of it. This vessel shows a mixture of ocean sails and remains of the usages of the Mediterranean in its long and low prow and in its stern of exaggerated height—two excesses that were not successively reduced until after many years, as may be seen by examining the Dutch vessel of 1680, and the Royal Louis of 1692, which Tourville commanded during the heroic battle of La Hougue. It will be seen that the sails are of wide surface, and that their maneuver is more easy. The bowsprit here is neither well placed nor properly held by cords, because much attention was as yet paid to defending the extremities of ships. This was necessary, since, in a calm, the vessel was immovable, while the lightest galley could assume any position that it desired. But the latter most powerful ships, there were lesser ones, such as the vessels of 80 and 74, and, finally, frigates which, as a whole, differed only in the number of their rows of cannon. Corvettes carried these latter only on deck. All had three masts; but the advantage obtained by a division of the sails has a limit, and, in diminishing in size, ships became two masted brigs, or schooners with sails in the shape of a trapezium, or, finally, single masted cutters.

The series of figures allow these changes to be appreciated, and causes us to admire the results of the efforts of science and human industry during the last centuries. To this had been added attention to the interior arrangement and an admirable order that had rendered an abode at sea as healthy as that in a dwelling on land, and which strongly contrasted with those maladies that, at the beginning of the century, made of navigation a play of fortune almost as dangerous as that of war. All this was the work of man, the result of his skill and of his collected efforts. It was he who mastered a surface of canvas which was sometimes of 4,500 square meters area, and which, when spread to the wind, gave the vessel the extent of a cathedral viewed from one side, and it was he who, by utilizing the peculiarities of the wind, surely reached the goal. Never have intelligence and courage been better shown. And, too, how many bold and dexterous things have been done on the yards in bad weather! The engine had not yet come to mix itself up with the efforts of man, but it has now reached that point of perfection that the sailing vessel has become depreciated. The majestic three-decker and the elegant frigate have been the song of the swan of navigation by sail, and perhaps also that of the intelligent officer and gallant sailor. Dexterity and boldness are replaced by fatigue and dirt; smoke blackens the sails, and the use of them is even dispensed with, and calms and contrary winds are becoming as much unknown as they formerly were known for their contrarieties. So we have come to the addition of an engine to the ship, and that connecting plateau, and, when once embarked on the Pacific Ocean, made a long voyage around Cape Horn, or through the Straits of Magellen The exploration of the Beni River in 1880, by Dr. E. R Heath, was therefore an important event to that republic, because the natural outlet for the largest portion of Bolivia is through the Amazon and its affluents to the Atlantic Ocean.

Previous attempts have been made to find a river outlet to the Amazon. Palacios, Prefect of the Department of the Beni, was commissioned by his Government in 1846 to explore the fluvial outlets of Bolivia. He descended the Mamore and Madeira Rivers as far as the lowest fall in Brazil, and ascended the Beni River 18 miles, where a fall placed an obstruction to his further progress. The same year a Prussian named Bursa attempted, with one hundred and fifty men and ten canoes, to ascend the Beni River. According to his report, he encountered hostile Indians, and, all his ammunition having been exhausted in conflicts with them, he was compelled to return. His men claim that they ascended the river for thirty days, and were occupied ten days in descending it. As they found no rapids, but discovered a large island where there were hills and floating patches of foam on the river, it is believed they only ascended 12 miles. Lieut. Gibbon was sent out in 1852 by the United States Government, but did not succeed in opening the Beni River.

Prof. James Orton, accompanied by Dr. J. D. Heath, attempted in 1877, as the crowning work of his South American explorations, to unveil the mysteries of this unknown region, over which had hung a superstitious fear for more than three centuries. But his twelve Bolivian soldiers, to whom he had paid in advance 1200 dollars in gold for services during the expedition, mutinied, on account of their fear of encountering cannibals on the Beni River While in camp beside the Mamore, which they had descended in canoes to within 24 miles of the mouth of the Beni, about

4 o'clock one afternoon, they suddenly placed their bayonets at the breast of Prof. Orton, and held them there defiantly a few moments in silence, and then marched off in a body. Taking possession of one of the boats, they drove into it ten of the Indian rowers at the point of the bayonet, and then turned the prow of the boat up stream, and left Prof. Orton to his fate. Forced to abandon his expedition Prof. Orton turned back heart-broken. When he reached Lake Titicaca, of legendary fame, completely exhausted, he threw himself upon some sail-cloth on the boat and, as if relieved of a great burden, said with deep feeling, "I am so glad, *so* glad. We will have no more mules, muleteers, or Indians; no more annoyance, trouble, or disappointment. I am so tired, *so* tired;" and then quickly fell asleep. During the night a terrific storm burst upon them, and their boat struggled for hours among the billows. But just before daylight of the next morning, September 25, 1877, the tempest lulled, seeming to have spent its force, and Prof. Orton suddenly became conscious that he was dying; and there among strangers, far away from his family and friends, gently, without complaint or a struggle, he died a martyr to Science. He was tenderly buried on a rocky island in Lake Titicaca, in sight of the scenes of his last expedition. A fine monument, erected by foreigners, on the summit of the island, just in front of Puno, is a fitting tribute to this celebrated discoverer, who will be remembered as long as the blue waves of this magical lake murmur around his last resting place, or the Sorratta range of the Andes, which stand in the background, lift up their snow-clad peaks.

Dr. E. R. Heath, who had been employed for six years as Medical Director of the Pocasmayo Railroad, one of the roads belonging to Henry Meiggs, was, on the return of his brother, Dr. J. D. Heath, who had been the assistant of Prof. Orton, greatly impressed with the importance of opening the Beni River to science and commerce. Two months afterward he left Peru, returned to the United States, and having prepared himself for the expedition, sailed from New York, November 23, 1878, for Para. Taking the first steamer, he ascended the Amazon to Manaos, and the Madeira to San Antonio, where the Madeira and Mamore Railroad was being constructed under P. and T. Collins. Here Dr. Heath remained until July 21, 1879, acting as Medical Director of this road, while he carefully studied the climate, diseases, and natural history of the country, and the customs and language of the people.

Leaving San Antonio at the latter date, he ascended the Madeira River to the junction of the Mamore and Beni, where he made a *chacra*, or clearing, and planted bananas, yuccas, oranges, and lemons. Departing from this point August 20, he ascended the Mamore, passing the mouth of the Itenez a river flowing northwest from the diamond regions of Matto Grosso, and arrived at Exaltacion September 9, 1879. Continuing his course up the river to the mouth of the Yacuma, he disembarked and left his canoes, and, after the delay of a week at Santa Ana, he secured carts and commenced his land journey across the Pampas to Reyes. During the dry season the journey between these points is made by carts, but the country is flooded during the remainder of the year, and the journey is made by boats on the river.

On September 30, 1879, Dr. Heath arrived at Reyes, and built a house, and made active preparations for the work before him. To become more familiar with the country, he made a voyage down the Yacuma to Santa Ana, and to Lake Rogagua, whose outlet is the River Negro, and also to Tumupaza and San Jose on the River Tuichi, correcting their geography. He remained at Reyes until August 3, 1880, occupied in making collections and in keeping a meteorological journal, when he embraced an opportunity of descending the Beni as far as the rubber camp Maco, near the mission Cavinas. Antenor Vasquez, the owner of this rubber estate, had forty Indians and boats to descend the Beni, for the purpose of discovering new places for rubber camps. Embarking with Don Antenor he descended the river five days to a point where Antenor Vasquez remained with most of his men, and Dr. Heath took a single boat with three Bolivians and nine Indians, and descended the river to a point as far as 11° 11' 29" S. lat., where he made a *chacra* and planted bananas, the customary method of showing where a descent had been made on the river. By the river this point is 375 miles below Reyes, and the Bolivians refused to go any further, on account of the general belief that the country contiguous to the Lower Beni was inhabited by cannibals. In passing the last rubber camp Dr. Heath found a family of Pacavara Indians, one of whom accompanied him on the descent, from whom he obtained some knowledge of the character of the Indians who occupy the country as far as the the River Madre de Dios.

From this point Dr. Heath was compelled to return to Maco, where he made preparations for a final descent of the river, which he believed could be successfully explored. As no one was found willing to risk his life on the Lower Beni, Dr. Heath determined to make the descent alone. But Don Antenor would not allow this, and offered him any of his men who would voluntarily accompany him. Ildifongo Roca, a Trinitarian Indian, was the only one found who was willing to go. Dr. Vaca, a Bolivian rubber gatherer, afterward furnished another Indian, and a boat 15 feet in length, which when loaded sank nearly to the water's edge.

The forest along the Beni River on the south side forms a margin from one to ten miles in width, and on the north side it becomes a part of the great Amazonian forest, which extends over 15 degrees of latitude. The Amazonian forest realizes the perfection of vegetable growth, and its magnitude and diversity serve to overcome and bewilder the traveler. The gigantic trees, 200 feet in height, are so thickly woven together at the top that not a direct ray of light can penetrate the dense foliage, and the parasites and vines at the bottom form such a matting and tangle that no one can force his way through except by cutting a path with the *macheta*. This sea of verdure extends from the treeless Pampas of Buenos Ayres to the grassy steppes of Venezuela. Here the law of the "survival of the fittest" is illustrated to its fullest extent, species struggling with species, and individual with individual, the weaker growth often climbing the more powerful neighbor while its roots are left to dangle in the air. These unconquered giants exhibit the greatest possible diversity, presenting an endless variety of growths, festooned, draped, matted, corded, and ribboned with plants creeping and climbing, starred with flowers and covered with parasites. The dense dome of green overhead serves to confine the growth of flowers to the edges of the forest, and to the banks of rivers and lagunes, and the absence of sunlight has probably deprived the few flowers that appear of the bright colors of the temperate zone. The tranquil waters of shallow lakes which border the Amazon, however, produce the royal water-lily (*Victoria Regia*), the most magnificent inflorescence in the world. It expands its broad leaves from 15 to 18 feet in circumference on the water, and unfolds its blossom a foot in diameter, which passes in a brief time from pure white to rose, and through the successive hues to bright red. Dr. Heath and his two Indians were from 6 o'clock in the morning until nearly noon cutting their way from the river through the forest to the Pampa on the south side, a distance of not over a mile, which they retraced in 15 minutes. When it is desirable to make a clearing in an Amazonian forest, a leaning tree is selected, and all the trees in the forest in front of it are cut on one side; then the vines are severed, and the leaning tree is cut down, when all the trees come down with a crash. The vertical rays of the sun soon dry the fallen timber, so that fires will burn up all except the trunks.

On September 28, 1880, Dr. Heath commenced his final voyage down the river. As he pushed his frail barque out upon the water, all the people gathered around and bade him adieu, firmly believing that he and his two Indian companions would be eaten by the cannibals supposed to be living along the Lower Beni. On October 7, at meridian, he arrived at the lowest point reached on his first descent, and stopped for the night at a point lower down, in 11° 4' 46" S. lat. The next morning at 8 o'clock he passed a stream coming in from the south, probably an outlet of a portion of the waters of Rojoaguado, an unexplored lake. To this river was given the name Ivon, in honor of the companion of Prof. Orton in his last expedition to South America. At 10 o'clock he passed a point of rocks in the river, and came to an island with a large sand-bar in front. At this point he landed, and climbed one of the tallest trees to obtain a view of the country, as the dense forest cut off his view on every side. Far to the south, beyond the perennial forest that margins the river, he could see the glimmering waters of an unknown lake. At meridian he came to the junction of the Beni with a large river flowing in from the north, undoubtedly the Madre de Dios. By triangulation he found the width of the Madre de Dios at the point of junction to be 2,350 feet, and of the Beni to be 735 feet, the depth of water in the channel being 50 feet. All animals here were found to be exceedingly tame. He landed on an island, at the junction of the two rivers, within ten feet of seven capibaras, which did not move, evidently never before having seen a man. The alligators found sleeping on the sand-bar did not stir, and the monkeys in the trees on the banks simply lifted up their heads while the boat passed under them, and then went to sleep again.

The only knowledge possessed of this river is the rumored descent of it in 1860, by Señor Maldonado, a Peruvian colonel of engineers, who, being persecuted in his country for political reasons, is said to have descended the Madre de Dios and Lower Beni, losing his life at one of the lower rapids. Unfortunately all the notes of this expedition were lost.

Alligators had taken out of the boat every night, while moored at the shore, the meat of monkeys killed for provision, which rendered it necessary to shoot monkeys every day. Alligators here were very numerous, and, on account of their great familiarity, Dr. Heath shot two to make them respect them. For greater precaution he placed the meat at night at the head of his bed, a s he slept on the shore near the boat, but in the morning the meat was gone, and the prints left by an alligator's feet and tail indicated by what means it was missing. He also found tracks of tigers in the sand near his sleeping place, and indications where they had dug up turtles' eggs.

The Doctor pushed off his frail boat at 6 o'clock in the morning, and at 6:50 passed the mouth of a large river flowing in from the north, to which he gave the name of Orton, in honor of the celebrated explorer. The land in this vicinity is low and marshy, with few trees. At midday he found a porpoise, which accompanied him all that day and a part of the next, until he came to the upper Rapids, just above the Falls. The appearance of this porpoise gave him great encouragement, as the Madeira and Mamoré Rivers are full of porpoises, but the Beni has none. It was an indication that there were no dangerous falls below him. During the day the tabanos, a horse-fly, both yellow and black with white-tipped wings, disappeared, and myriads of sand flies took their place. These sand flies are found on all the tributaries of the Amazon, and Humboldt estimated that on the Orinoco there are a million of these flies to every cubic foot of air. There are two species of these sand flies, called pium and maruim, differing only in size. During the night, while the Doctor was taking an observation with his sextant, the mosquitoes alighted on his face in such numbers that the blood trickled down on his garments. They got into his eyes, and alighted on his mercury, and disturbed his mercurial horizon to such an extent that he could not take his usual observation. The burning of the Pampas had so filled the atmosphere with smoke that he was compelled to work his artificial horizon without its usual glass cover, and stars of the first magnitude appeared as dim as those ordinarily of the fourth and fifth magnitude. The change from the tabanos to the maruims caused him to remember that the same change took place on the Mamoré just above the Falls, and he believed he was approaching the Falls corresponding to the same point in the Mamoré. In the distance he saw tapering columns of smoke escaping from the leafy roof of the forest, which probably curled up from fires burning at Indian camps beneath.

The next day the Doctor saw two turkeys on the bank, so tame that he shot one, and reloaded and shot the other while it stood looking at his fallen companion. The same day he passed two large islands, and at 10 o'clock in the morning he reached a point where the river was obstructed by rocks, forming a rapid current, which he passed without difficulty, and soon afterward reached the main Falls. Failing to find a suitable passage for his boat on the north side, he passed over to the south side of the river, where he succeeded in drawing the boat over the rocks to the waters below. The difference of level between the water above and below the Falls is 28 feet, the angle of descent of the water in the main shoot is 25 degrees, and the falling water points toward the southern shore, making a dangerous whirlpool, which was passed with great difficulty, his frail bark being almost swamped. The Doctor found a little bank below the Falls, where the two Indians managed to sleep while he sat in the boat all night writing and inking over his pencil notes made during the day, and occasionally bailing out the water from the boat, which had sprung a leak from the concussions received on the rocks the previous day. About 7 o'clock the next morning he passed a number of rocks in the river corresponding with the Rapids Palo-Grande of the Mamoré; for here he recognized the range of hills which he had seen while ascending the other river. Just below this point there is a large island where Palacios spent the night in 1846, and the last point probably arrived at by Bursa, the Prussian explorer.

Dr. Heath now informed his Indian companions that they were near the termination of their voyage, as he recognized from the hills, and the islands four miles below the Falls, that they had passed what corresponded to the fourth Falls in the Mamoré River. Ildifongo then asked if there was now hope for their lives? When informed that there was, he said he would call the falls Esperanza or Hope. From this place they had an unmolested passage to the mouth of the Beni River, where they arrived October 11, 1880. Here they found the *chacra* which the Doctor had made in August, 1879. There were over two hundred bunches of bananas, ripe and decaying, which furnished them an abundance of food. As the bananas had not been touched, the Doctor inferred the absence of Indians. Loading the boat nearly to the water's edge, they began the ascent of the Mamoré, and passed the first night at the foot of the first Rapids. But his Indian companions, having gorged themselves with food, were taken sick, and were unabled to proceed for two days.

In ascending the Mamoré Dr. Heath met with a serious accident at the Falls of Palo Grande, where his boat was overturned and submerged in a fearful whirlpool, his cutting utensils lost, and all his provisions thrown into the river. The situation was critical in the extreme, and the Indians were stupefied with terror. Dr. Heath first secured his boat, then seeing his *farinha* sewed up in an ox-hide, and two of his paddles, floating around in the center of the dangerous whirlpool, he plunged into the river. The Indians beheld this hazardous act with amazement, and uttered a cry of terror. Should the Doctor be drowned, how could they escape from the wilderness? and, if they should escape, they would probably be shot under the suspicion of murdering him. Swimming to the *farinha*, the Doctor placed his hand upon it, and, being carried round and round in the surging whirlpool, he gradually pushed it out; after which he secured two of his paddles in a similar manner, escaping from the whirling water after these almost superhuman efforts in a perfectly exhausted condition. When the boat passed the Falls, it was reloaded with the instruments which had been taken out and carried around. But the Doctor's paddle of green wood had sunk in the whirlpool, and he had lost all his tools for making another. Fortunately he found a piece of wood that had been roughly blocked out for a paddle, and by charring the wood and rubbing off the charred portion with a sharp stone he made himself another paddle. In this he displayed the same fertility of invention to supply his necessities which characterized the whole expedition. Their frail bark now leaked very badly, and the waves ran so high on the river during stormy weather that sometimes they were compelled to tie up to the shore. One night, while camping on the shore, the Doctor noticed that the boat began to fill with water, and he had barely time to arouse the Indians from sleep and unload the boat before it sank. On the following day, after much hard work, the boat was made to float, when it was reloaded, and they pursued their way.

On the 20th of October, while on the Brazilian side of the Mamoré, Dr. Heath heard some one calling, and saw with a field glass a naked Chacobo Indian, who was standing on the sandy shore of the opposite side, and was trying to induce them to come across the river. When no attention was paid to him, twenty armed savages sprang out from the shelter of the trees, where they were lying in ambush ready to attack the boat should it approach that shore.

Without any further accident Dr. Heath arrived at Reyes December 11, where he was received with every demonstration of joy. The school children, hearing of his safe return, went out from the town about three miles to greet him with songs and floral offerings. When he arrived at Reyes the church bells were rung, and there was a public ovation.

Soon afterward Dr. Heath ascended the Beni River on a balsa raft, and thus completed the map of the river from its mouth to its source near La Paz, when he took his departure from South America, and October 16, 1881, he arrived in New York.

Most fruitful in results has been the exploration of the Beni River. It has materially corrected the geography of that portion of South America. Two hundred leagues square of rubber trees have been opened to commerce, where each square league will contain from three hundred to five thousand trees. This will furnish work to large numbers of men ten months in the year, each man being able to collect from 10 to 25 pounds of rubber daily. It shortens the route of transportation of the products of the Lower Beni from 700 miles to less than 300, and necessitates the passage of only one fall in the river instead of five falls. For the larger portion of Bolivian commerce it obviates the toilsome transit over the Andes, and the long voyage around Cape Horn or through the Straits of Magellan.—*Jour. of Science.*

EXPLORATIONS IN GUATEMALA.

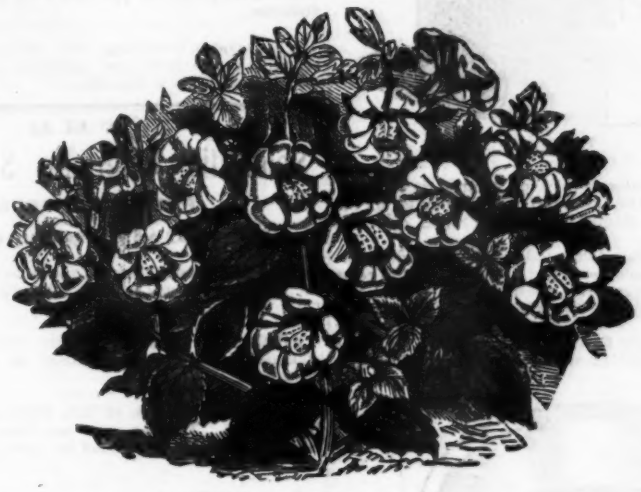
MR. A. P. MAUDSLAY, mentioned in M. Charnay's researches, has published separately some of his own personal explorations, with a map and ground-plans. Starting from Livingstone, Guatemala, he first visited Quirigua, whose ruins consist of raised mounds and terraces, usually faced with stone, and near to these carved monoliths. The latter are of two kinds: high upright stones, ornamented with human figures and tables of hieroglyphics; and low broad stones, in the shape of some animal. The first named measure three to five feet across, and 12 to 25 feet out of the ground. On both back and front, the principal ornament is a human figure in relief, decked out in the barbaric splendor usual throughout Central America. Mr. Maudslay suggests that the inevitable human face on the thorax may explain the function of the great number of masks from this quarter. The second class of carvings is very interesting. One specimen, weighing about eighteen tons, represents a turtle having a human head, with projecting ears richly ornamented. In place of the tail is the life-size figure of a woman sitting cross-legged, and holding a manikin scepter in her hand. The whole surface of the block is profusely ornamented. Nowhere in the neighborhood are there traces of houses. The exploration at Quirigua led to an attempt to fix the site of Chaciyal, mentioned by Cortez.

Leaving this spot, Mr. Maudslay visited Copan, where the sculptures impressed him as being above those of Quirigua in execution. From Copan our traveler wandered next to Tikal, northeast of Lake Peten, only once before visited by a foreigner, Bernouilli. All the houses here are built of stone, and coated with plaster. Inside, the walls are seven to eight feet high, and the stone roof form a narrow gable. The rooms within are very narrow, resembling long passages. The town was laid out in a rectangular form, the slopes terraced with sustaining walls. The houses are often built on raised foundations, stone-faced in the same manner. The most imposing buildings are the five temples raised on pyramidal foundations, in front of which are

steep stairways leading up to the doors of the temples. There is no trace of any idol or object of worship in these buildings, but carved slabs and circular altars are found in the plaza. The next point of interest was a ruined town on the Usumacinta. On the top of a steep bank 60 feet high stands the first row of houses, and the town is built on a succession of stone-faced terraces reaching more than 250 feet in height. Instead of the long, narrow interiors, as at Tikal, the houses are broken into a number of recesses by buttresses supporting the roof at intervals, and stone is used instead of sapote-wood for lintels. One of the houses at Usumacinta is minutely described by Mr. Maudslay. In nearly all the houses, around the idols, stand earthen pots partly filled with some resinous substance, which the Lacandon Indians probably placed there, showing that the old faith has not died out. At this point Mr. Maudslay met M. Charnay. This very important paper closes with a short sketch of the Lacandones.—*Proc. Roy. Geogr. Soc.*

MIMULUS CUPREUS BRILLIANT.

THE pretty little coppery red Mimulus has been a favorite with most people ever since it has been introduced from the Chilian Andes, and the attention bestowed upon the raising of it from seed has resulted in obtaining several distinct and beautiful varieties. The older forms of it are tigrinus and variegatus, both with flowers quaintly and brightly spotted, and the double variety, or rather a hose-in-hose kind. All these are distinct from the type itself, an extremely pretty plant, but all are surpassed in brilliancy, neat and compact



MIMULUS CUPREUS BRILLIANT.

growth, and floriferousness by the new variety which Messrs. Carter have obtained and named Brilliant. We lately saw a broad mass of this mimulus in full flower at their St. Osyth seed grounds, and thought at the time that we had rarely seen a more glorious bit of coloring, viz., a glowing crimson-red inclined to orange, as near as one can describe it. There were thousands of plants in the quarter just alluded to, all without exception being not more than from 4 inches to 6 inches in height, spreading, and forming a dense tuft, profusely studded with flowers. It is, indeed, a valuable plant, and one that could be made to produce a bright effect in a graden if properly placed; but to obtain the best results from it, it must be seen *en masse*, say in a bed 6 feet square, and it never looks better than when placed in a retiring nook, not too shaded, on a lawn surrounded by greenery, and rising from a carpet of grass. It is a plant which does best in a moist loamy soil, and which well repays good culture. It is a perennial, and quite hardy enough to last several seasons, and the best plan is to raise seedlings of it in autumn and plant them out the following spring. W. G.

THE TWIN FLOWER.

(*Linnæa Borealis.*)

In many a northern pine wood this modest little evergreen trailing plant is just now displaying its delicately tinted blossoms; no wonder that such a lovely plant is such a

SPRAY OF LINNÆA BOREALIS.

favorite with all who love flowers, for it spreads and forms a dense cushion-like tuft, which becomes thickly studded with tiny pink bells. It is a rare native and not at all a common plant in gardens, though it is not so difficult to cultivate as many imagine; like the Edelweiss, another reputedly difficult plant, it flourishes like a weed if placed under the necessary cultural conditions. All that is needed is to plant healthy young plants in a moist sandy border, rock garden, or slightly raised bank. Placed in such a position and in partial shade, we have rarely found it difficult to deal with, always presuming, of course, that the air is pure. The best season for transplanting strong plants of the twin flower is autumn, and care should be taken to secure a good amount of earth lifted with the roots.—*The Garden.*

THE SPREAD OF EPIDEMIC DISEASES IN PLANTS.

By W. G. FARLOW of Cambridge, Mass.

IN the case of animals it can be said that, excepting the diseases attributed to bacteria, they are subject to but few diseases caused by fungi. In the case of plants, however, the greater part of the diseases to which they are subject are caused by parasitic fungi; excepting, of course, the injuries caused by insects, which need hardly be considered in speaking of epidemic diseases. Most of the violent epidemic diseases of plants are caused by fungi of the orders Uredineæ, rusts, and Peronosporeæ, rots. Fortunately the species of these orders attack only a single species of host, or at most several species closely related botanically; so that, for instance, a rot which would attack the potato would not probably attack the grape, although it might be expected to attack the tomato, which is botanically closely allied to the potato. As might be expected, the most violent epidemics occur during, or just after, unusually wet periods. An epidemic disease spreads either by the dispersion of its spores through the air, or by the transportation of the host plant on which it is growing; the latter being probably the means by which diseases are carried across large bodies of water, as the Atlantic.

With the introduction of food plants from Europe to this country come, of course, many of their parasitic diseases. It should be noted, however, that the most violent plant epidemics of recent times have advanced not from east to west, but from west to east. The best known case is that of the potato rot in 1845, and since then the very accurately recorded case of the grape mildew, Peronospora viticola, has arisen. In the first case, the disease is supposed to have reached Europe from the west coast of South America, by way of the United States. In the latter case, the grape mould, which is a native of North America, can, as I showed by experiments in 1876, be transferred to the European vine; and it was prophesied that the disease would extend to Europe, and do more harm than with us. The prophecy was very soon fulfilled, as you all know. In the two diseases just mentioned, it is a characteristic of the spores, that in germinating, instead of giving off a filament, they discharge a number of motile zoospores, each of which is capable of propagating the disease. We have several other species of Peronospora which produce zoospores, some of which have apparently crossed from America to Europe; and there are others which, although common in this country, have not yet appeared in Europe, although, following the grape mould, they may be expected to appear there hereafter. Among these may be mentioned Peronospora Halstedii, which grows on composites, and may later be found in Europe on the Jerusalem artichoke. Professor Trelease has recently found a Peronospora on Sicyos, in Wisconsin, which resembles the grape mould in general appearance. The germination of the spores has not yet been observed, but, judging by analogy, one would expect them to produce zoospores. It would not be surprising if the Peronospora on Sicyos should also be found hereafter causing a disease of squashes or melons; and its progress eastward might be expected as in the cases previously cited.

The speaker then referred to a modification of the spores sometimes observed in Peronospora. Mr. Earle, of Cobden, Ill., collected species on geranium and viola, where, instead of the usual branching spore stalks, the spores were borne on the mycelium close to the breathing pores; the spores themselves being very much larger than in the common form. A similar monstrosity has been noted by Cornu, in the grape mould. The specimens were collected by Mr. Earle, in April, and the speaker suggested that this form of spores might perhaps be an adaptation to the cold and wet weather of spring. The conditions which produce the monstrous forms are worth considering by collectors.

Of the diseases caused by Uredineæ, which have advanced from west to east, the hollyhock disease, Puccinia malvacearum, is the best known instance. Its original home was probably Chili; but it spread through Europe about ten years ago, not, however, by way of this country, as was probably the case with the potato rot. The diseases produced by fungi of other orders, as Ascomycetes, do not spread with the same rapidity as the rusts and rots. This is shown by the black knot, which is so destructive in this country to plums and some kinds of cherries. It is a native of this country, and is found on most of our wild species of Prunus, especially the choke cherry, a shrub which has been introduced into many places in Europe. As yet, however, the black knot has not made its appearance in Europe.

The speaker then said that he had just found the grape mildew growing on the Virginia creeper (Ampelopsis quinquefolia) near Minneapolis. As this plant is closely related to the vine, the occurrence of the mildew might have been expected. In attempting to prevent the spread of the disease to countries where it is now unknown, the discovery is of importance. It is evident that, to prevent the spread of the disease, the importation of Ampelopsis as well as of grape vines must be prohibited.—*Proc. Amer. Association.*

THE SINGING BEACH OF MANCHESTER, MASS.

By A. A. JULIEN, of New York, and H. C. BOLTON, of Hartford, Conn.

SANDS were taken from the so-called "singing beach" on the coast of Massachusetts, near Manchester-on-the-Sea, and subjected to microscopical examination. In this beach, the felspathic rocks are intersected by numerous dikes of igneous rocks, among which porphyritic diorite is noticeable. The phenomenon which gives rise to the name of the beach is confined to the portion of sand lying between the water-line and the loose sand above the reach of ordinary high tide. Portions emit the sound; but closely contiguous areas fail to do so, or answer feebly. The sounding sand is near the surface; at the depth of one or two feet it ceases, perhaps because of moisture. The sound is produced by pressure, and may be likened to a subdued crushing; it is of low intensity and pitch, is not metallic nor crackling. It occurs when the sand is pressed by ordinary walking, increases with sudden pressure of the foot upon the sand, and is perceptible upon mere stirring by the hand, or even plunging one finger and removing it suddenly. It can be intensified by dragging wood over the beach.

The authors review and cite very fully the literature of the subject, giving in full a description of the singing sands of the island of Kaui, one of the Hawaiian group. That gives a sound as of distant thunder, when anything of weight is dragged over it. Dampness prevents the sound. That sand is calcareous. Hugh Miller cites similar instances at Jebel Nakous in Arabia Petræa, and Reg Rawan near Cabul. Those are silicious sands. The sounds were a sort of humming.

In Churchill County, Nevada, a similar phenomenon is described with regard to a sand-hill, as like the sound of telegraph-wires when wind blows them.

The authors also review and characterize the various sands of different mineral origin.

To explain the sonorous peculiarity of the sand, several theories are considered. That of equality, or of the unequal size of the grains, is rejected. Cellular structure has been supposed, but is not found in the present instance. Effervescence of air between moistened surfaces does not apply to this case. Sonorous mineral, such as clinkstone, is not present. There is no evidence of electrical phenomena being concerned. The hypothesis adopted is that the sand, instead of being, as ordinarily, composed of rounded particles, is made up of grains with flat and angular surfaces. In the present instance, the plane surface of felspar is apparent in many of the grains. Probably a certain proportion of quartz and felspar grains is adapted to give the sound, while less or more of either component would fail of the result.

Dr. Bolton has himself examined a sand of similar quality, on the island of Eigg in the Hebrides, and has described its properties. That is largely calcareous. Its constitution is a mixture of large and small grains, and larger ones being rounded quartz. Many small, angular fragments of quartz are also contained, and many dark granules of chert, the last being about three or four per cent of the whole, and having a cellular structure.

It is concluded that the sound is produced either by the intermixture of grains having cleavage planes, or of grains with minute cavities. The paper ends with a table of the physical structure of the sands of many localities.—*Proc. Amer. Assoc.*

THE FOEHN OF GREENLAND.

THE climate of the Arctic regions, and particularly that of the west coast of Greenland, presents the peculiarity that the temperature is the most unstable during the cold season. Not only does there exist a striking difference between the mean of each month for successive years, but in the course of the same month rapid changes are observed; to the most severe cold succeeds a rapid rise, and *vice versa*. These elevations of temperature form one of the grounds which leads Nordenskjold at this moment to Greenland.

The mean temperature of the month of February in 1872 was 8·7° Centigrade below zero; it was 31·5° Cent. below zero in 1863, or during a period of eleven years a difference obtains of nearly 23°. It is difficult to conceive of such contrasts, as at Paris the difference between the means of the coldest and hottest months of the year is only 16°. The diurnal variations are not less surprising. During the month of February, 1866, the thermometer passed three three times in 24 hours the point of 7·2° above zero. On the third of February, 1871, the thermometer marked in the morning —25°, in the evening —14°, and on the morning of the next day it attained to + 1°.

On the 31st of January, 1873, at 2 P. M., the temperature was —21°, while at 11 A. M. it had been + 1°.

It is not only at Jacobshavn that these irregularities are noticed; they are most marked at that place, but they are found all along the west coast of Greenland and appear simultaneously over the greater extent of that region.

It is to Dr. Rink that we owe the first plausible interpretation of this phenomenon. It was published in 1857, and Dr. Pfaff has since developed it.

A glance at the map shows that Greenland is surrounded by regions of which the meteorological conditions are essentially different. While to the west and southwest Labrador, the territory of Hudson Bay, and the Arctic islands have a mean winter temperature of — 20° to — 35°, the gulf stream maintains on the east and southeast upon the Atlantic a mean of 0° to + 5°, so that the atmosphere at this level is about zero. Therefore the direction of the wind should be of great importance to Greenland, and the mean of each winter depends upon the reciprocal predominance of the warm winds of the east and southeast, or the cold winds of the west and southwest. For instance, during the winter of 1874-1875 the west coast of Greenland was covered with floating ice as far as the eye could reach from the summits of the mountains, although in ordinary seasons at this time the coast would be clear. And yet, despite these exceptional conditions, the winter was relatively mild, because the winds of the south and southeast prevailed.

Although the southeast wind should be for the west coast a relatively warm wind, it does not suffice to explain the very considerable elevation of the temperature when it blows; at Jacobshavn the normal temperature of the middle of December is — 12°; should one observe at this time a temperature of 8° to 9° above zero it would be attributed to the ex-

cess of heat furnished by the Atlantic winds, of which the temperature, low at + 8°, has been lowered in crossing Greenland, although it requires but 8 to 10 hours for them to traverse it. But there has been observed in December on the west coast temperatures of + 18°, and it is necessary to go down to the Azores to find at this time an equivalent degree of heat.

Besides its elevated temperature the southeast wind is very dry, and it is this consideration that has led observers to compare it with the Foehn of the Alps which, after crossing from the south to the north the snowy peaks of these mountains, reaches their northern slope dry and warm, with a temperature of 6° to 8° higher than one has reason to expect. Dr. Hann of Vienna has given the explanation of it.

The atmospheric pressure decreases as the altitude increases, the air which rises along the slopes of the Alps dilates during its ascension, and in doing so absorbs heat and is cooled. As long as it can retain the aqueous vapor in suspension, calculation has proved that it is cooled 1° Fahr., 0·5556° Cent., for each ascent of 180 feet. When it has passed the dew point, clouds form; it rains or snows; the vapor of water is condensed, and its latent heat disengaged. The refrigeration past this point is consequently lessened in rate, and is not more than 0·5° Fahr. for each 180 feet.

On the contrary, when the air has passed the summits and has gained the valley, the increase of pressure will compress it in its descent, its temperature will rise beyond the dew point, it will retain its vapor of water, and, as it becomes heated 1° Fahr. for each 180 feet of descent, it will appear both dry and warm upon the north slope of the Alps. The same wind which brought snow to the southern slope raises the temperature upon the northern.

The features of the Foehn of the Alps are reproduced in the south and southeast winds of Greenland. M. Pfaff, allowing to the mountains of the interior a medium height of 6,000 to 7,000 feet, calculates that a current of air which makes the ascent of these mountains gains 18° Fahr., on the assumption that it absorbs 0·5° Fahr. for every ascent of 180 feet. Thus a wind which has 5° temperature on the east coast of Greenland, although it loses many degrees of heat in crossing a desert of ice of 400 miles width, will yet have on arriving at Jacobshavn 5·5°, 7·7°, and even 10° Cent. This, however, does not explain all. How is it that this southeast wind produces temperatures in some winters of 10° Cent. whereas at others it scarcely diminishes the intensity of the cold or produces inappreciable effects.

Nordenskjold rests upon these meteorological conditions his assurance of success in his exploration of the interior of Greenland. He accepts the theory of Foehn. But if it is true, there can be no glaciers in the interior of Greenland since upon each incline or slope from the interior the winds which blow from the east shore or west reach the interior deprived of their moisture. They have been only able to produce snow or rain in any quantity at the summits of the ranges sufficient to form glaciers upon the slopes *facing the sea*. Far from being a field of ice, the interior of Greenland, may be a fertile plain; and, in fact, the reindeer, which in winter disappear over the mountains, cannot take this direction without hope of pasturage.—*Journal d'Hygiène.*

A NEW FISH-HATCHING APPARATUS.*

By VON LA VALETTE ST. GEORGE.

THE progress which has been made in the culture and care of fish in our waters has caused the invention and application of many different kinds of apparatus for the further development of artificially impregnated eggs.† Much as they differ from each other in form, the most important variation in their construction is this, that, in some, the water which moistens the eggs (which are spread on a sieve-like frame) is introduced from the top, and, in others, from the bottom.

During an experience of more than twenty years I have tried all the different apparatus which I could obtain, both old and new, and with all of them—Jacobi's hatching-box, Coste's hatching-apparatus, Kuffer's hatching-pot (which cannot be too highly recommended), and troughs made of wood, sandstone, cement, and granite—I have attained my object, if the principal condition for successful hatching, a sufficient quantity of clear water of the right temperature, was fulfilled; although the California principle of introducing the water from below, on which Von dem Borne's and Eckardt's ingenious apparatus are based, may deserve the preference.

Aiming at the removal of some noticeable defects, caused by too complicated a construction or unsuitable material, I constructed, two years ago, after numerous experiments, a new hatching apparatus, which I have practically tested during the last two winters. The object which I had in view was to obtain an apparatus as comprehensive, simple, and handy as possible as to its form, and made of a material which would not be affected by the hatching-water, and would not favor the injurious development of fungi. The form is, in its main features, that of the "hatching-bucket," described in the circulars of the German Fishery Association for 1879, p. 107, and the material used is faience.

I shall give a brief description of this apparatus, which, in its construction, offers no technical difficulties whatever, and which I hope will not only prove useful to the practical pisciculturists, but also prove a valuable aid in the prosecution of embryological studies.

It consists of two vessels, one fitting in the other. The outer one is of cylindrical shape, 26 centimeters deep, and measuring 30 centimeters across. The upper edge protrudes 1 centimeter.

On the outside a tube is fastened, which widens into a funnel at the top and serves for admitting the water; its diameter is 6 centimeters, and just above the bottom of the vessel it communicates with the interior by means of an opening 5 centimeters wide. Opposite the inflow opening, the edge of the vessel is cut out 5 centimeters, and has an outlet 8 centimeters broad and 9 centimeters long, which is slightly inclined. Immediately above the opening of the tube described above, and 5 centimeters above the bottom of the vessel, a projecting edge, 1 centimeter thick and 1·5 centimeters broad, runs all around the inner side of the vessel. On this flat edge rests the second vessel, which is 20 centimeters deep, and whose bottom is perforated by numerous very small openings. Up to a height of 5 centimeters the side of the inner vessel rises perpendicularly; for the next 5 centimeters it is inclined 2 centimeters toward the inside, and above this it again rises perpendicularly. The upper edge, 2 centimeters broad, is bent over. The second division of the inner vessel, showing in its section an angle projecting toward the inside, is perforated along its entire circumference, just like the bottom.

The application of this apparatus will easily be understood. Through the tube on the outside the water flows in, entering the bottom of the outer vessel; through the perforated bottom of the inner vessel it enters into this and moistens the eggs, which may cover the bottom to the height of 5 centimeters; the water now goes through the perforated part of the circumference of the inner vessel, and

FIG. 1.

passes again into the outer vessel; but it must rise 5 centimeters higher, in order to flow out through the outlet of the outer vessel. In one minute 3 liters of water can pass through the apparatus.

The advantages of this construction will be readily perceived. In the first place the upper frame, which prevents the inspection of the eggs, which easily becomes too tight, and which injures the young fish when they press against it, is dispensed with. The perforated wall of the inner vessel lets as much water flow off into the outer vessel as flows in through the perforated bottom. But as the outlet

FIG. 2.

of the outer vessel is still 5 centimeters higher than the perforated ring of the inner vessel, and consequently there must still be a depth of water of 5 centimeters above this, there is no current toward the perforated ring of the circumference; and the young fish are not exposed to any injury, especially of the umbilical bag, by being driven against the sides of the vessel, which danger is in other apparatus averted by large and inconvenient sieve-like frames.

What are known as "catch-boxes" (*Fangkasten*) are entirely unnecessary, as the fish which may happen to slip out

FIG. 3.

have still above them a space 5 centimeters in height, free of water, and there is therefore no chance whatever of their escaping. Unless for some special reason, it is deemed desirable to place them in a larger body of water, the fish may safely be left in the apparatus till they are fully developed.

Although this apparatus can easily hold 5,000 eggs, it takes up very little room, is clean, and easily handled.

By lifting and pressing down the inner vessel, the eggs can easily be moved for the purpose of picking them over.

It is true that faience, like so many of our household utensils, is fragile. If, therefore, the person who is to handle the apparatus suffers from chronic clumsiness, it may be constructed of tin, wood, stone, or cement.

This hatching-pot cannot be considered expensive, certainly not more expensive than other apparatus of this kind, as it may be obtained at the reasonable price of 10 marks ($2.38) from the porcelain and faience factory of Ludwig Wessel, in Bonn.—*Bull. U. S. Fish Commission.*

* "*Ein neuer Fischbrut apparat*," von V. La Valette St. George. Bonn, 1882. Translated from the German by Herman Jacobson.

† Commencing with its number for October 15, 1881, the "*Bayerische Fischerei Zeitung*" contains a long and highly valuable historical and critical article on "Hatching-apparatus for Salmonidæ," etc., from the pen of one of our foremost pisciculturists, Mr F. Zenk, president of the Lower Franconia Fishery Association, in Wurzburg.

CLEANING WATER PIPES.

CAST iron pipes are the best for water under pressure. In a longer or shorter time they generally become incrusted according to the quality of the water, the deposit consisting for the greater part of oxide of iron and carbonate of lime. A thorough cleansing of these pipes is one of the most important problems of the engineer. Three methods, says the *Centralblatt der Bauverwaltung*, have been suggested:

1. Taking out the pipes from time to time, heating them, and scraping out the deposit that is loosened by the heat.
2. Cleaning them with brushes and scrapers before the deposit gets hard.
3. Dissolving the deposit with acid.

The second method has been used with great success in Nuremberg and Carlsruhe. A brush that nearly fills the tube is run back and forth in the pipe while in use. The muddy slime is washed out immediately by the flow of water. In Carlsruhe the network of pipes is 14 miles long, having a diameter of 4 to 18 inches, and were all cleansed within 78 days in this manner. The expense was $575, or about 2½ cents per yard. For the purpose of introducing the brushes, the pipes are provided with manholes at suitable distances.

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